OPERATOR'S AND MAINTENANCE MANUAL
(INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

LIGHT EMITTING DIODE VISIBLE AND INFRARED CARMANAH PRECISION APPROACH PATH INDICATOR

Technical Support:
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21 May 2012

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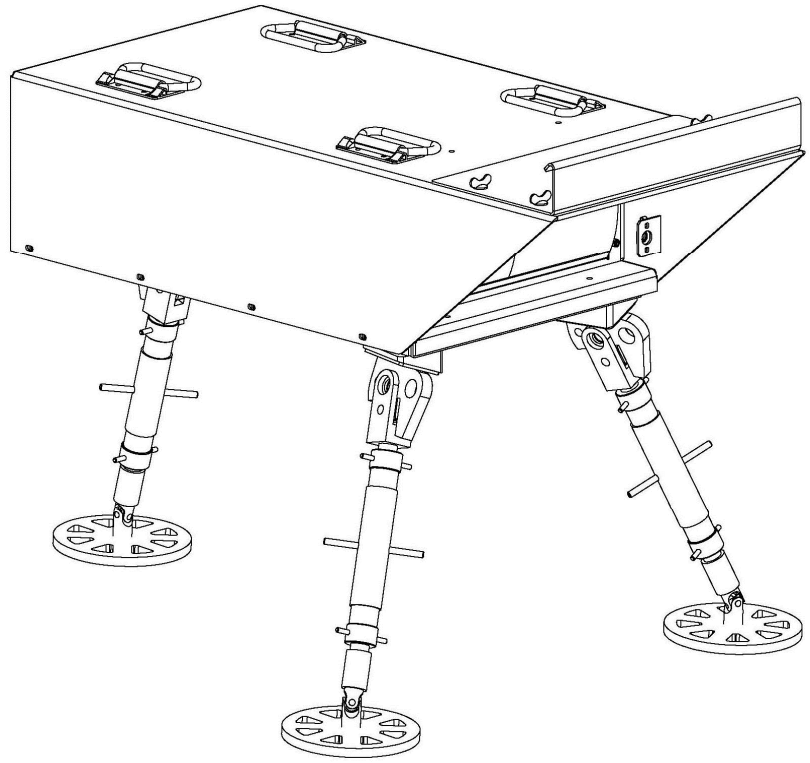
TECHNICAL MANUAL

OPERATOR'S AND MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

LIGHT EMITTING DIODE VISIBLE AND INFRARED CARMANAH PRECISION APPROACH PATH INDICATOR



Light Housing Assembly with rapid deployment legs for portable operation

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WARNING SUMMARY

HANDLING

The Light Housing Assemblies (LHA) contain glass components. Care should be taken to avoid unnecessary shock. Do not drop.

The Light Housing Assembly (LHA) is designed to be transported in the horizontal position. Refer to Chapter 7, Preparation for Movement.

DO NOT store, carry, or use the Battery Box Assemblies (BBA) in any position other than the top side up.

DO NOT STEP on the top of the Light Housing assemblies (LHA), Battery Box Assemblies (BBA), or Power Control Unit (PCU).

IMPROPER CLEANING AGENTS

Improper cleaning methods and use of unauthorized cleaning agents can injure personnel and damage equipment. Refer to Chapter 9, Maintenance.

INCLINOMETER

DO NOT place battery in backwards. Refer to Appendix B, Inclinometer Instructions.

The digital inclinometer must be calibrated before use to ensure accurate readings. To calibrate, perform the Superset instructions in Appendix B.

POWER SOURCES

DO NOT connect the Power Control Unit (PCU) directly to the DC output of a generator or any unregulated power source. Refer to Section 5-2, Power, for instructions.

DO NOT connect power to the Power Control Unit (PCU) control panel power switch to the "ON" position. Failure to do so may result in damage the power sources or the PCU. Refer to Section 5-2, Power, for instructions.

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Chapter 1. General Information

1-1 Scope

a. Type of manual: Operator's Manual.

b. Model number and equipment names:
Light-Emitting Diode Visible and Infrared Precision Approach Path Indicator, CT-LED-PAPI

c. Purpose of equipment: airfield approach glideslope guidance

d. Location terms: Throughout this manual, the terms “front”, “rear”, “top”, “bottom”, “starboard side”, and “port side” are used to describe the views of the light housing assemblies (LHA). Glass lenses are located on the front panel. The power connector and manufacturer’s labels are located on the rear panel. The port side is the side to the right when looking at the front of the LHA, and the starboard side is the side to the left when looking at the front of the LHA.

1-2 Reporting Equipment Improvement Recommendations

If you have recommends for improvement, please let us know. You, the user, are the only one who can tell us what you don't like about your equipment. If you have feedback on a Carmanah Aviation product, please contact us at aviation@carmanah.com.

1-3 List of Abbreviations

The following is a list of abbreviations for Carmanah Airfield Lighting Systems. Some terms listed below may not be used in this document.

A	ampere
AC	alternating current
AGM	absorbed glass mat
AH	ampere-hour
APAPI	Abbreviated Precision Approach Path Indicator
BBA	Battery Box Assembly
cm	centimeter
DC	Direct Current
FAA	United States Federal Aviation Administration
ft	foot
Hz	Hertz
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
in	inch
IR	Infrared
kg	kilogram
lb	pound (US)
LED	Light Emitting Diode
LHA	Light Housing Assembly
mm	millimeter
MTBF	Mean Time Between Failure
NATO	North Atlantic Treaty Organization
NSN	National Stock Number

NVE	Night Vision Equipment
NVG	Night Vision Goggle
PAPI	Precision Approach Path Indicator
PCB	Printed Circuit Board
PCL	Pilot Controlled Lighting
PCU	Power Control Unit
RCT	Remote Control Transmitter
s	second
STANAG	(NATO) Standardization Agreement
TDZ	Touchdown Zone
V	volt
VAC	volts, alternating current
VDC	volts, direct current

Chapter 2. Equipment Description and Data

2-1 Equipment Characteristics, Capabilities, and Features

The CT-LED-PAPI is an approach path indicator that utilizes highly efficient light emitting diode light (LED) sources to provide glideslope guidance to aircraft on final approach to landing. It is based on the characteristics of the Precision Approach Path Indicator with visible and infrared signals.

General Description
The CT-LED-PAPI provides visual glideslope guidance to pilots on approach to landing that indicate an aircraft's vertical position with respect to the proper glideslope.

Light emitting diodes (LED) provide corridors of red and white lights emanating from a location that is off to the left side of the landing zone. The PAPI is composed of a power control unit and four light housing assemblies. Each light housing assembly (LHA) projects beams of steady white and steady red light. The indication for proper glideslope is two LHA showing a red light and the other two showing a white light to the pilot on approach to landing. When the aircraft is well above the proper glideslope, then the pilot sees white lights from all four LHA. When the aircraft is above the proper glideslope, then the pilot sees white lights from three LHA and a red light from one LHA. When below the proper glideslope, then the pilot sees red lights emanating from three LHA and a white light from one LHA. When well below the proper glideslope, then the pilot sees red lights emanating from all four LHA.

Infrared light emitting diodes provide corridors of steady and modulated infrared (IR) light that is night vision goggle (NVG) compatible. The corridor of steady IR light corresponds and overlaps the white light corridor, and the corridor of modulated IR light corresponds to and overlaps the red light corridor. The flash rate is 2 per second, and the modulation pattern is 50% on, 50% off. The indication for proper glideslope as seen with NVG is two LHA showing a flashing light and the other two showing a steady light to the pilot on approach to landing. When the aircraft is well above the proper glideslope, then the pilot with NVG sees steady lights from all four LHA. When the aircraft is above the proper glideslope, then the pilot with NVG sees steady lights from three LHA and a flashing light from one LHA. When the below the proper glideslope, then the pilot with NVG sees flashing lights emanating from three LHA and a steady light from one LHA. When well below the proper glideslope, then the pilot with NVG sees flashing lights emanating from all four LHA.

General Performance Specifications
Carmanah provides a variety of options and alternatives for its LED-based Precision Approach Path Indicators (PAPI) and Abbreviated Precision Approach Path Indicators (APAPI). The Model CT-LED-PAPI has the following characteristics:

- **4 Light Housing Assemblies for the 4-box configuration**
- **visual signals are compliant with L880 photometrics**
- **5 levels of intensity**
- **infrared sources provide night vision goggle (NVG) compatible signals**
- **radio remote control (Tactical Lighting Systems controller)**
- **configured with rapid deployment legs**
- **battery operation, 24 VDC**
- **batteries charged by 200 to 400 VAC, 50/60Hz**
- **batteries charged by solar panels**
- **tilt switch**
- **photocell for autonomous operation**
- **inclinometer included**

2-2 Major Components

The PAPI Mk II system is composed of the following major components:
four light housing assemblies (LHA), part number CH6507;
power control unit (PCU), part number CH6572; and
battery box assembly (BBA), part number CH6567.

Also included are:
inclinometer;
one BBA to PCU cable, part number CH6540;
four LHA cables, part number CH6538;
tie-down straps and stakes.

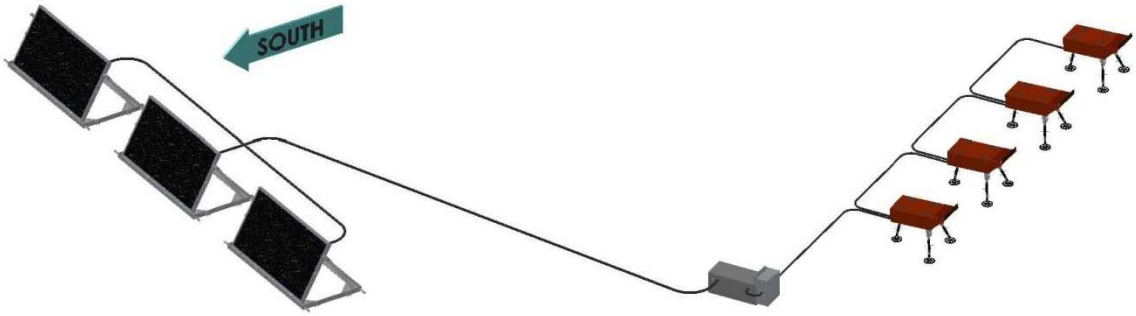


Figure 2-2.1: Layout of a Carmanah portable solar module connected to a Carmanah PAPI.

2-3 Light Housing Assembly

The light housing assemblies (LHA) are 14.2 inches (360 mm) wide, 30.7 inches (780 mm) long, and 6.6 inches (194 mm) high. The weight of an LHA with the rapid deployment legs is 37 lb (17 kg).

Figure 2-3.1: A Light Housing Assembly (LHA).

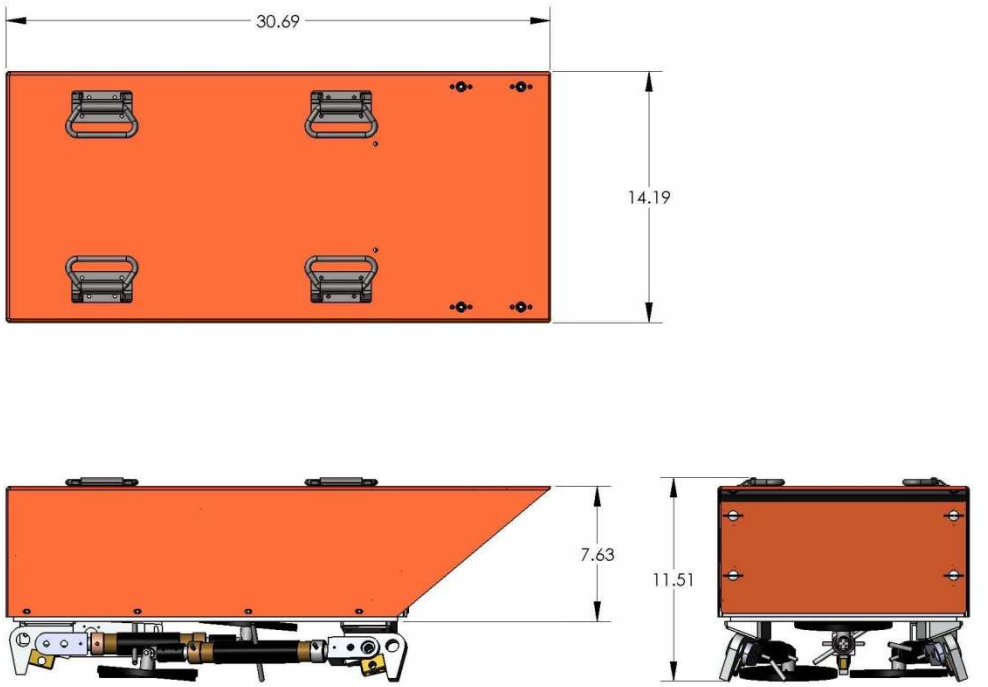


Figure 2-3.2: Light Housing Assembly (LHA) dimensions.

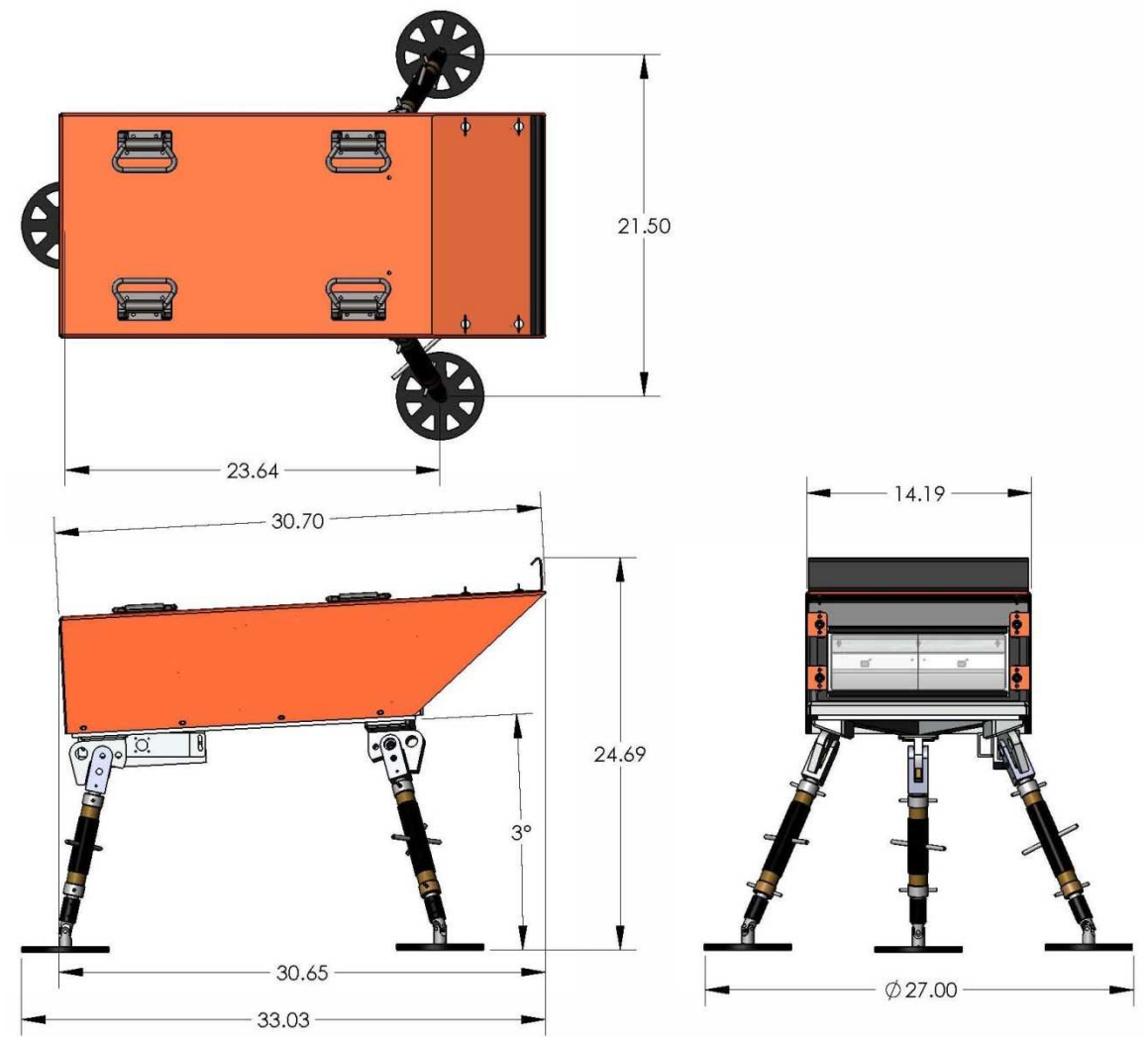


Figure 2-3.3: Light Housing Assembly (LHA) dimensions (in inches) with the rapid deployment legs extended.

2-4 Power Control Unit

The LHA are powered and controlled from the power control unit (PCU). The PCU box is 14 by 12 by 6 inches (36 x 31 x 15 cm). The PCU requires 24 VDC and uses 330 W of power when the four LHA are on at the highest intensity (daytime) setting and 50 W in IR (NVG-compatible) mode.

Figure 2-4.1: Two views of the Power Control Unit (PCU) attached to the Battery Box Assembly.

The PCU control panel has switches for system on-off control, radio remote or local operation, visible or IR operation, and five choices for the intensity levels. Intensity step 5 is high (100%), intensity step 4 is 20%, intensity step 3 is 4%, intensity step 2 is 0.8% and the lowest intensity step 1 is 0.16%. The PCU control panel also has toggle switches for tilt switch bypass and to enable photocell operation.

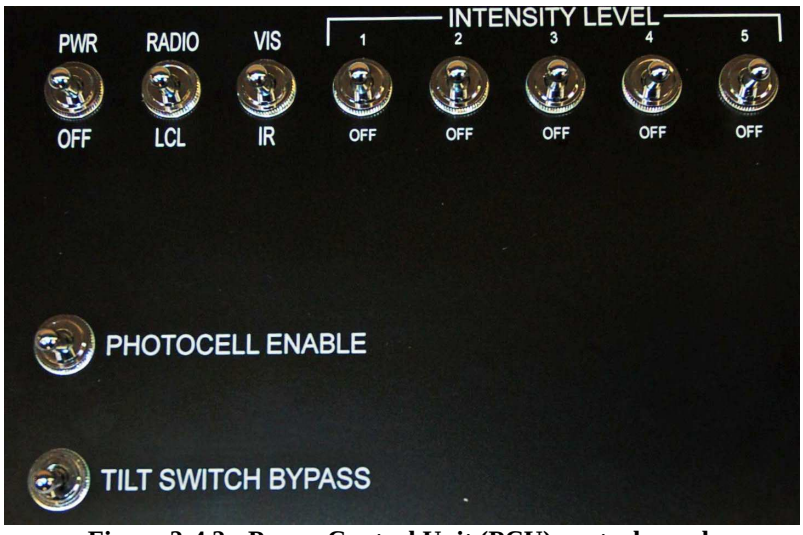


Figure 2-4.2: Power Control Unit (PCU) control panel.

The PCU has an input connector for power from the Battery Box Assembly on its starboard side panel. Also on this side panel are connections for radio remote control. See the Tactical Lighting Systems manual for information on these connections.

Figure 2-3.3: Power Control Unit (PCU) starboard side panel connections. On the top is the receptacle for radio remote control power; in the middle is the receptacle for the radio connection; and on the bottom is the receptacle for 24 VDC input power.

On the other side panel is a connector for the LHA connection cable. The LHA cable is 36-ft long and had 19 pins. All four LHA cables are identical.

Figure 2-4.4: Power Control Unit (PCU) port side panel receptacle for the cable to the LHA. The cable from the PCU to the LHA is identical to the other three LHA-to-LHA cables.

2-5 Battery Box Assembly

The Battery Box Assembly (BBA) box is 12.6 inches wide by 26.1 inches long by 11.4 inches high (32 x 66 x 29 cm). The BBA weights 150 lbs (68 kg). The BBA contain AGM-type batteries that supply 24 VDC to the PCU for 14-hour duration at the night setting (intensity step 4, 20%). The BBA plugs into the PCU. The batteries of each BBA are recharged by 200 to 400 VAC, 50/60 Hz, which is input on the side of the BBA.

The charge time for a Battery Box Assembly with AC power is 4.5 hours under normal conditions.

Figure 2-5.1: A Battery Box Assembly (BBA).

There is a power inlet receptacle towards the rear of the starboard side of the BBA for the AC input voltage. There is also a receptacle for a solar array input power and a receptacle for pass-through 400 VAC power. Towards the front of the starboard side of the BBA is a 24 VDC output receptacle which connects with the BBA-to-PCU cable to the PCU. The BBA-to-PCU cable is 2-ft long and has 3-pin connectors.

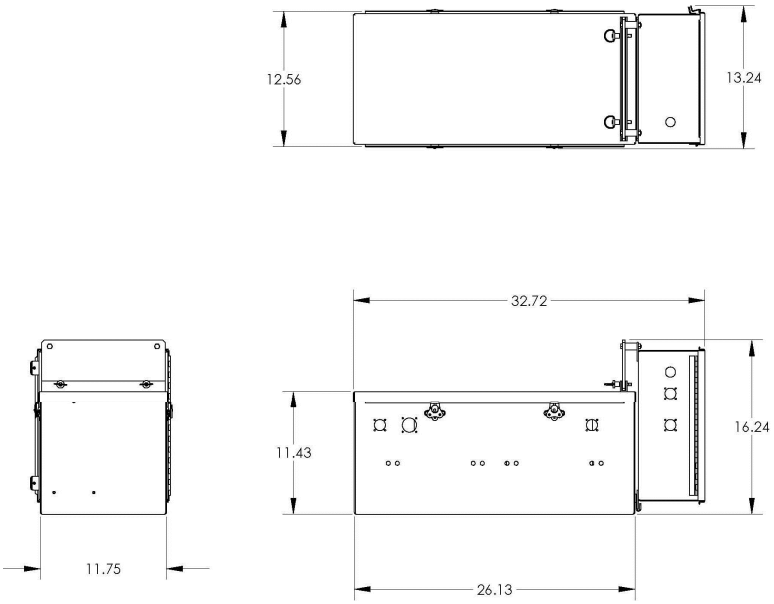


Figure 2-5.2: Dimensions of the Battery Box Assembly (in inches)

Figure 2-5.3: Battery Box Assembly receptacles: the solar panel input is in the middle and the 400 VAC input is on the right. The receptacle on the left is a pass-through of the 400 VAC input.

Figure 2-5.4: Battery Box Assembly 24 VDC output receptacle.

DO NOT store, carry, or use the Battery Box Assemblies (BBA) in any position other than the top side up.

2-6 Inclinometer

A digital inclinometer is included to set the side-to-side level and tilt angles of the LHA. Instructions for its use are contained in Appendix B. Note that the inclinometer is a third-party item. The NSN of the inclinometer is 5210014180671.

Figure 2-6.1: Picture of the digital inclinometer

Chapter 3. Theory of Operation

3-1 Light Housing Assembly (LHA)

Light-emitting diodes (LED) have significant advantages over conventional lighting. Estimates of LED lifetimes range from 100,000 hours up to 10,000,000 hours, which can be compared to the 1,000 to 2,000 hours for conventional incandescent bulbs. The LED is a solid-state device with no fragile glass bulbs or filaments that are susceptible to shock and vibration. And the LED is significantly more efficient at conversion of electrical power into illumination than conventional lighting. Besides being more efficient, there are no losses through filters, so that depending on the color, the efficiency of LED is a factor of 5 to 20 greater than incandescent bulbs. Thus LED-based lighting has much low power consumption and requires small diameter cables for continuous operation. In addition, the light beam from the LED can be formed to be directional, so that light does not need to be wasted in directions where it is not desired or useful. There is also increased safety in handling since the LED does not get significantly hotter than its environment. In addition an LED light has multiple sources which permits continued operation when it experiences a failure or damage.

The light housing assembly (LHA) utilizes a row of high power visible LEDs to generate light of the required color, either red for the bottom corridor, or white for the top corridor. The signal format seen by the pilot is illustrated in Figure 3-1.

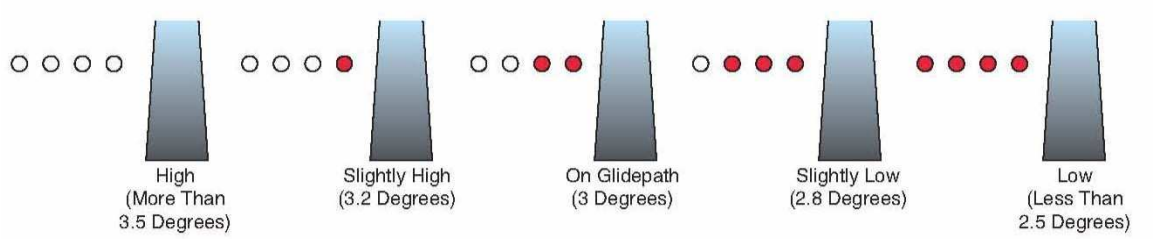


Figure 3-1.1: Signal format as seen by pilot on approach to landing for the 4-box configuration.

Light emitting diodes (LED) provide corridors of red and white lights emanating from a location that is off to the left side of the landing zone. Each of the light housing assemblies (LHA) projects beams of steady white and steady red light. The indication for proper glideslope is two LHA showing a red light and the other two showing a white light to the pilot on approach to landing. When the aircraft is well above the proper glideslope, then the pilot sees white lights from all four LHA. When the aircraft is above the proper glideslope, then the pilot sees white lights from three LHA and a red light from one LHA. When below the proper glideslope, then the pilot sees red lights emanating from three LHA and a white light from one LHA. When well below the proper glideslope, then the pilot sees red lights emanating from all four LHA.

Infrared light emitting diodes provide corridors of steady and modulated infrared (IR) light that is night vision goggle (NVG) compatible. The corridor of steady IR light corresponds and overlaps the white light corridor, and the corridor of modulated IR light corresponds to and overlaps the red light corridor. The flash rate is 2 per second, and the modulation pattern is 50% on-50% off. The indication for proper glideslope as seen with NVG is two LHA showing a flashing light and the other two showing a steady light to the pilot on approach to landing. When the aircraft is well above the proper glideslope, then the pilot with NVG sees steady lights from all four LHA. When the aircraft is above the proper glideslope, then the pilot with NVG sees steady lights from three LHA and a flashing light from one LHA. When the below the proper glideslope, then the pilot with NVG sees flashing lights emanating from three LHA and a steady light from one LHA. When well below the proper glideslope, then the pilot with NVG sees flashing lights emanating from all four LHA.

3-2 Power Control Unit (PCU)

The Power Control Unit (PCU) receives 24 VDC power from the Battery Box Assembly (BBA) and control signals from the Tactical Lighting Systems radio remote Control transmitter. The PCU sends power and control signals to each of the Light Housing Assemblies (LHA). The PCU has switches on its control panel to select the operating mode of the PAPI.

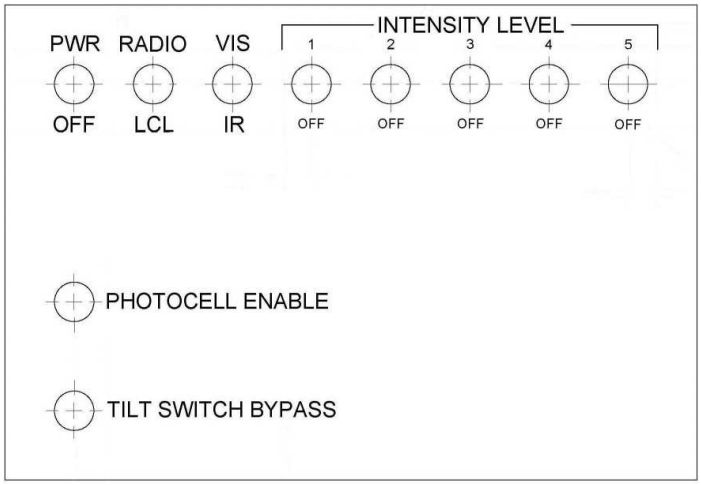


Figure 3-2.1: Power Control Unit (PCU) control panel.

The toggle switches on the top row of the PCU control panel are used to: turn the system on and off; select radio remote control or local manual control; choose visible or near-infrared, NVG-compatible (IR) beams; and 5 intensity steps (the IR/VIS and Intensity controls only function from this panel when in LCL mode). The toggle switches on the bottom of the PCU control panel are used to enable and disable autonomous photocell control of day or night intensity settings; and enable or disable the tilt switches on each LHA.

3-3 Battery Box Assembly (BBA)

The BBA contains two 12 VDC, 75 AH AGM-type batteries that supply 24 VDC to the PCU. The BBA plugs into the PCU. The batteries of the BBA are recharged by 200-400 VAC, 50/60Hz, which is input on the side of the BBA. There is a circuit breaker with an on-off switch inside the BBA.

The solar modules will also charge the BBA. The solar charge controller is located in the BBA. When AC Charging is being used it will charge the batteries, and the system will revert to solar automatically when the AC is disconnected or turned off.

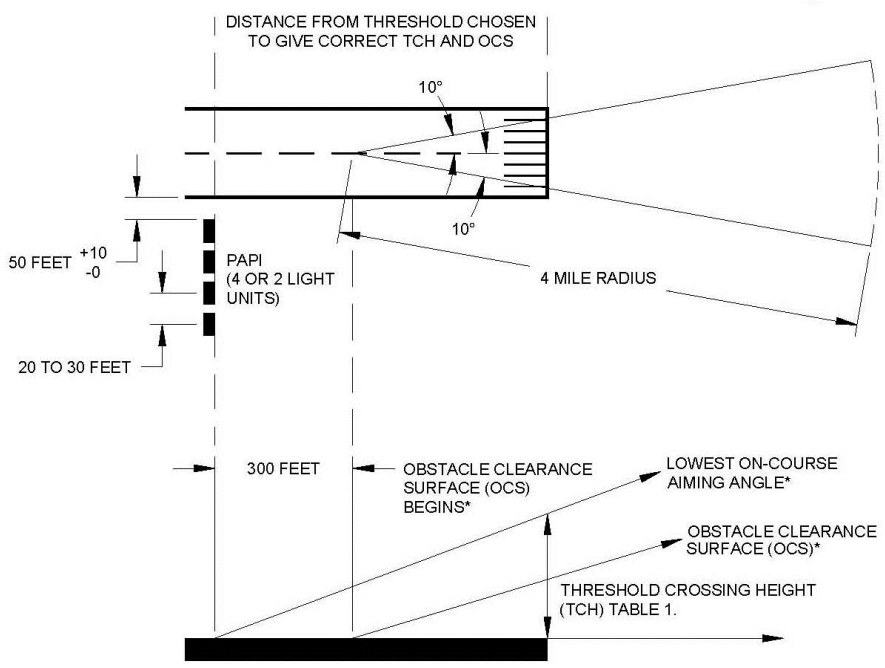
DO NOT store, carry, or use the Battery Box Assemblies (BBA) in any position other than the top side up.

DO NOT STEP on the top of the Battery Box Assemblies (BBA).

Chapter 4. Set Up and Installation

4-1 Site Requirements

The PAPI should be placed near the runway in accordance with the specifications from the applicable regulatory agency, for example FAA or ICAO. The PAPI is placed to the left of the runway as seen by the approaching aircraft across from the touchdown zone. The location is determined based on the type of aircraft, the grade of the runway, the nominal glideslope angle, and the height of the LHA above the ground. As an example, Figure 4-1 illustrates some of the specifications from FAA AC 150/5340-30d. Note that the site requirements are more complex than illustrated in this figure as they must take into consideration the aircraft type, the grade of the runway, and whether or not there is an ILS. In addition, there are different rules for a general aviation runway used by non-jet aircraft.



PAPI OCS ANGLE = LOWEST ON-COURSE AIMING ANGLE - 1 DEGREE

NOTES:

1. THE VISUAL GLIDE PATH ANGLE IS THE CENTER OF THE ON-COURSE ZONE, AND IS A NOMINAL 3 DEGREES WHEN MEASURED FROM THE HORIZONTAL SURFACE OF THE RUNWAY.

   A. FOR NON-JET RUNWAYS, THE GLIDE PATH MAY BE RAISED TO 4 DEGREES MAXIMUM TO PROVIDE OBSTACLE CLEARANCE.

   B. IF THE PAPI GLIDE PATH IS CHANGED TO A HIGHER ANGLE FROM THE NOMINAL 3 DEGREES, IT MUST BE COMMUNICATED IN A NOTICE TO AIRMAN (NOTAM) AND PUBLISHED IN THE AIRPORT FACILITY DIRECTORY.

2. PAPI OBSTACLE CLEARANCE SURFACE (OCS).

   A. THE PAPI OCS PROVIDES THE PILOT WITH A MINIMUM APPROACH CLEARANCE.

   B. THE PAPI MUST BE POSITIONED AND AIMED SO NO OBSTACLES PENETRATE ITS SURFACE.
      (1) THE OCS BEGINS 300 FEET [90M] IN FRONT OF THE PAPI SYSTEM.
      (2) THE OCS IS PROJECTED INTO THE APPROACH ZONE ONE DEGREE LESS THEN AIMING ANGLE OF THE THIRD LIGHT UNIT FROM THE RUNWAY FOR AN L-880 SYSTEM, OR THE OUTSIDE LIGHT UNIT FOR AN L-881 SYSTEM.

Figure 4-1.1: Diagram of the layout on the runway for PAPI Light Housing Assemblies (LHA) from FAA AC 150/5340-30d. This is an example only, the installer is responsible for placing the LHA in accordance with the specifications from the applicable regulatory agency, for example FAA or ICAO.

The light housing assembly nearest the runway ("LHA-1") should be placed with the front (the side with the lenses) facing towards the approach end of the runway (the approach end is the end from which aircraft will be coming) and with the sides of the LHA parallel to the runway at a distance from the runway as specified by the appropriate regulatory agency. The location of LHA-1 and tolerances on the placement of the LHA-1 must be in accordance with the appropriate regulatory agency. For example, the tolerance on azimuthal aiming in UFC 3-535-01 and AC 150/5340-30D is ±0.5 deg. Adjust the incline angle of LHA-1 with the procedure in Section 4-3, except that for a standard FAA installation, the LHA nearest the runway is set at an incline that is 30 arcminutes (0.5°) above the glide path within ±3 arcmin (0.05 deg).

The second light housing assembly ("LHA-2") is placed further from the runway edge than the first LHA, with its front facing towards the approach end of the runway and with its sides parallel to the runway at a distance from LHA-1 as specified by the appropriate regulatory agency. The location of LHA-2 and tolerances on its placement must be in accordance with the appropriate regulatory agency regulations. For example, the tolerance on azimuthal aiming in UFC 3-535-01 and AC 150/5340-30D is ±0.5 deg and the beam centers of all of the LHA must be within ±1 inch of a horizontal plane. Adjust the incline angle of LHA-2 with the procedure in Section 4-3, except that for a standard FAA installation, LHA-2 is set at an incline that is 10 arcminutes (0.17°) above the glide path within ±3 arcmin (0.05 deg).

The third and fourth light housing assemblies are placed further from the runway adjacent to LHA-2 and spaced with the same distance as between LHA-1 and LHA-2. The locations of LHA-3 and LHA-4 and tolerances on their placement must be in accordance with the appropriate regulatory agency regulations. For example, the tolerance on azimuthal aiming in UFC 3-535-01 and AC 150/5340-30D is ±0.5 deg and the beam centers of all of the LHA must be within ±1 inch of a horizontal plane. Adjust the incline angle of LHA-3 with the procedure in Section 4-3, except that for a standard FAA installation, LHA-3 is set at an incline that is 10 arcminutes (0.17°) below the glide path within ±3 arcmin (0.05 deg). Adjust the incline angle of LHA-4 with the procedure in Section 4-3, except that for a standard FAA installation, LHA-4 is set at an incline that is 30 arcminutes (0.5°) below the glide path within ±3 arcmin (0.05 deg).

There must not be any obstructions in front of (towards the approaching aircraft) the four LHA in order for the pilot to see both LHA on the approach to landing. **The obstruction clearance must be in accordance with the appropriate regulatory agency.** The ICAO standards have an obstacle protection surface 0.9° below the aim angle of the outer (lower) LHA.

4-2 Unpacking Items from the Shipping Container

Light Housing Assemblies

Each PAPI Light Housing Assembly (LHA) is shipped in a container. The associated LHA to PCU cable, 3 tie-down stapes, and 6 stakes are also located in the container. The dimensions of the container are 40 inches by 24 inches by 16 inches (102 x 61 x 41 cm). The other items are located on the system trailer.

Figure 4-2.1: PAPI system shipping container.

Place the shipping container with the labeled side up. Unclip the hold-downs from all around the perimeter of the shipping container. Pull off the top cover of the shipping container. Pull the LHA up from the container. Take the cable out of the container. Remove the tie-down straps and the stakes.

Replace the top of the shipping container and secure the latches.

4-3 Deployment of the Light Housing Assemblies

When the optional rapid deployment legs are implemented, the following procedure is used to install the LHA.

Remove the locking pin from one of the front legs by pushing on the center knob then pulling the pin outwards. Let down the leg, and then pull the foot away from the LHA until it reaches its stop. Secure the leg into its extended position with its locking pin. Remove the locking pin from the other front leg, let down the leg, and then secure it into its extended position with its expanding pin. Remove the locking pin from the rear leg, let down the rear leg, and secure it into its extended position with its locking pin.

(a) Remove locking pin from one of the front legs.

(b) Let down the leg.

(c) Pull the foot until it reaches its stop.

(d) Secure the leg with its locking pin.

Figure 4-3.1: Sequence for extending one of the legs.

Orient the LHA so that its front (the side with the glass lenses) is facing the approach end of the runway. Rotate the LHA until the side of the weather cover is parallel to the runway centerline.

Check procedure: Alignment in the azimuthal direction can be checked by measuring the perpendicular distance from the runway centerline to a side of the weather cover, then setting a mark the same distance forward of the LHA and perpendicular to the runway centerline. The LHA is then rotated until the mark is visually sighted along the same edge of the weather cover from which the distance to the runway centerline was measured. Note that either side of the weather cover can be used, so long as the same side is used for the distance measurement and sighting. Also note that any distance forward of (or backward from) the LHA can be used, but if an equal distance is used, then it can be marked with any linear length (e.g. a string) and does not require a tape measure.

Pull all three legs outward to their maximum extension so that the LHA is stable with no rocking.

Shield

Remove the shield from in front of the lenses by twisting four 1/4-turn fasteners counterclockwise to release. Place the shield on top of the LHA weather cover so that the angled piece sticks up at the front edge of the weather cover. Lock the shield in place by pushing the 1/4-turn fasteners into their respective holes and turning clockwise until they lock.

Setting the LHA level and at the proper tilt angle

To set the LHA level and at the proper tilt angle, first set the central turnbuckle on all three legs so that they are near the middle of their adjustment range, by rotating the turnbuckle using the pegs that stick out the sides. The brass locking mechanisms may have to be backed away from the central locking turnbuckle. Note that if the LHA have been set up previously, then starting from the middle position may not be necessary.

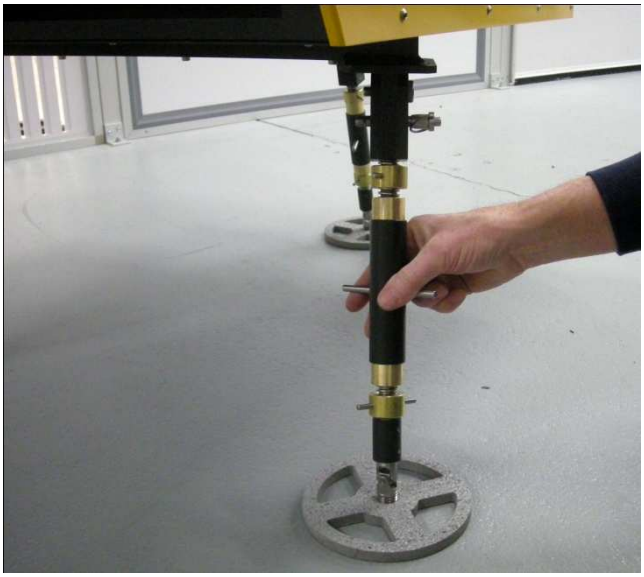


Figure 4-3.2: Start the leg adjustment by setting the turnbuckles on each leg to the middle of their adjustment range.

To set the LHA level side-to-side, place the inclinometer in the middle of the front of the base plate, as shown in the photograph below. Rotate the inclinometer so that it is aligned with the front edge of the base plate, perpendicular to the runway direction. If the optical head is dirty from previous use, then first clean the base plate in the spot where the inclinometer will be placed.

Figure 4-3.3: To set the side-to-side angle of the LHA, place the inclinometer in the middle of the front of the base plate so that it is aligned with the front edge of the base plate.

Adjust the front leg lengths until the inclinometer shows level. Adjust one front leg shorter and the other front leg longer until the inclinometer indicates level within ±0.05 deg (3 arcmin).

Clean the top of the inclinometer bracket. Place the inclinometer on the top of the inclinometer bracket and tighten the thumb screws. A picture that shows the proper position on the inclinometer bracket is shown below.

Figure 4-3.4: To adjust the legs in order to set the proper incline angle of the LHA, place the inclinometer on the inclinometer bracket.

Adjust the rear leg of the LHA until the incline angle is proper according to the appropriate regulatory agency. For example, for a 2-box configuration if the runway glideslope is 3 degrees, set LHA-1 (nearest to the runway) at 3.25±0.05 degrees (3 deg 15±3 minutes) and LHA-2 at 2.75±0.05 degrees (2 deg 45±3 minutes). For example for a standard installation of a 4-box configuration and the runway glideslope is 3 degrees, then set LHA-1 (nearest to the runway) to 3 deg 30 min, LHA-2 (next adjacent) to 3 deg 10 min, LHA-3 to 2 deg 50 min, and LHA-4 (outermost) to 2 deg 30 min.

Secure the leg length adjustment by tightening the two lock nuts on each leg by turning the pegs on the lock nuts until the lock nuts are snug against the turnbuckle, as shown in the figure below.

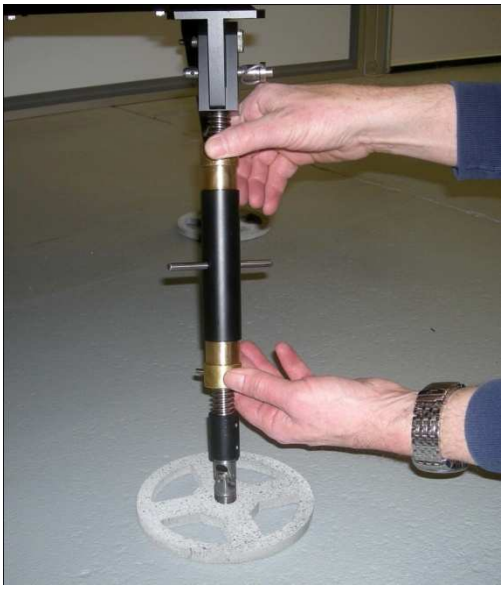


Figure 4-3.5: Tighten the lock nuts against the turnbuckle.

Secure the three feet with pegs or stakes through the feet and straps from the handles to stakes. The stakes are 12-inch Type II steel tent pin, NSN 8340-00-823-7451, that is heat treated to a hardness of 40-48 Rockwell C. The hardened steel allows the tent pin to be driven into frozen ground and pavement.

Figure 4-3.6: A staked leg of a Light Housing Assembly (LHA).

Thread the end of a strap through the hole on the rear leg. Secure the strap in a loop using the he buckle end of the strap Hammer in a ground stake directly behind the LHA at a distance so that the strap will reach. Loop the strap onto the ground stake and tighten.

Figure 4-3.7: Strap looped through the hole on a rapid deployment leg.

Thread the end of a strap through the hole on one of the side legs. Secure the strap in a loop using the he buckle end of the strap. Hammer in a ground stake at an angle in the horizontal of about 120 degrees from the strap in the rear. Loop the strap onto the ground stake and tighten. Repeat for the other side leg.

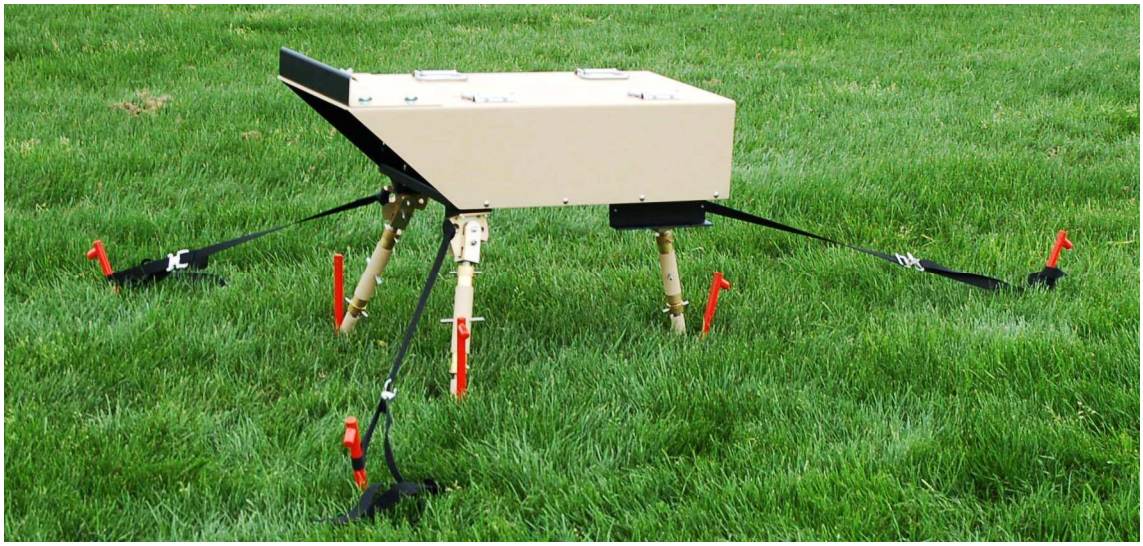


Figure 4-3.8: A deployed Light Housing Assembly (LHA). Note stakes are not fully in place for illustration purposes only, stakes should be fully driven in.

Re-check for the proper incline and side-to-side level. Adjust as required.

Connecting Cables

For LHA-1, connect an LHA cable to the female receptacle on the LHA. The receptacle is located on the bottom of the LHA near the rear. The LHA cable is 36-ft long and has 19-pin connectors.

For LHA-2 and LHA-3, then connect the cable from the inner LHA to the male receptacle and another LHA cable to its female receptacle.

If this is LHA-4, then connect the LHA cable from LHA-3 to its male receptacle, connect an LHA cable to it female receptacle, and then connect the other end to the PCU. Note that all four of the LHA cables are identical.

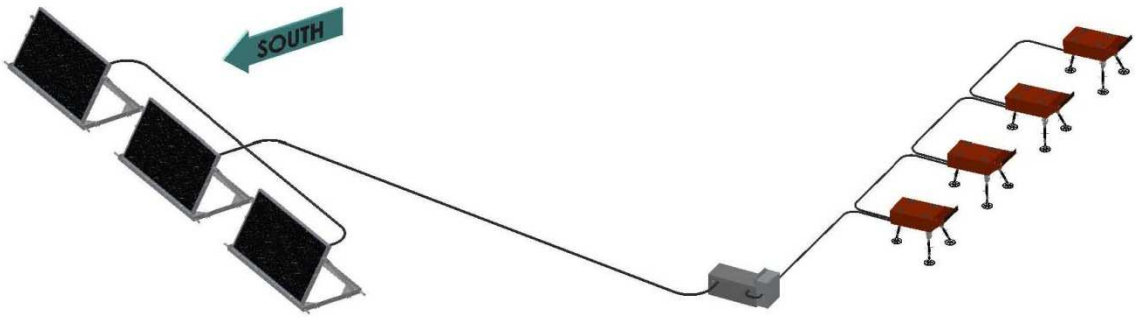


Figure 4-3.9: Layout of the connecting cables.

Tilt Switch

Place the "Tilt Switch Bypass" toggle on the PCU control panel in the disable (up) position.

Clean the bottom of the tilt switch assembly. Place the inclinometer against the bottom of the tilt switch assembly. Loosen the screw on the front side of the tilt switch bracket. Adjust the tilt switch with the inclinometer firmly against the bottom of the tilt switch until the inclinometer reads level within ±0.05 deg (3 arcmin). Tighten the screw that holds the tilt switch in position.

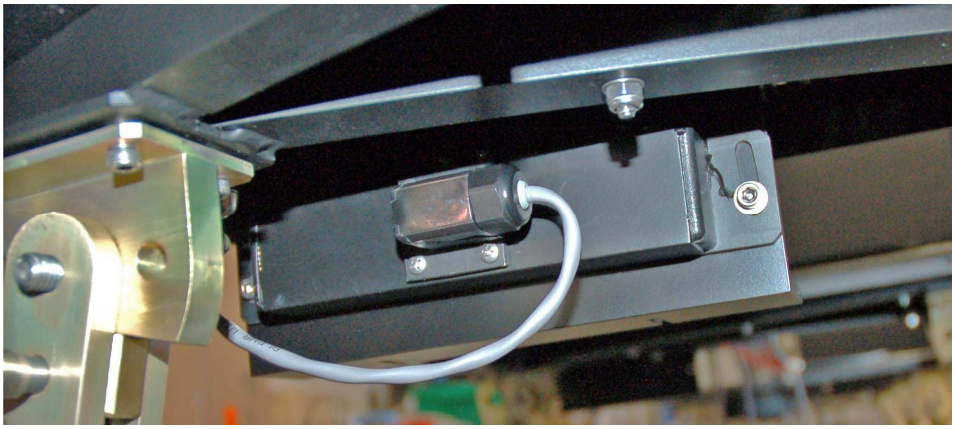


Figure 4-3.10: Tilt switch assembly. Note the screw on the front side (on the right in this picture).

If this LHA is the last LHA in the chain of cable connections (typically the LHA that is closest to the runway) place the tilt switch toggle on the bottom of the LHA into the position pointed towards the rear of the LHA by first pulling the toggle out past its stop, switching the toggle, then letting the toggle spring back. **DO NOT FORCE** the toggle switch, just pull it out before moving to change positions. This action completes the tilt switch series electrical circuit.

If this LHA is not the last LHA in the chain of cable connections, place the tilt switch toggle on the bottom of the LHA into the position pointed towards the front of the LHA by first pulling the toggle out past its stop, switching the toggle, then letting the toggle spring back. DO NOT FORCE the toggle switch (pull it out to change positions).

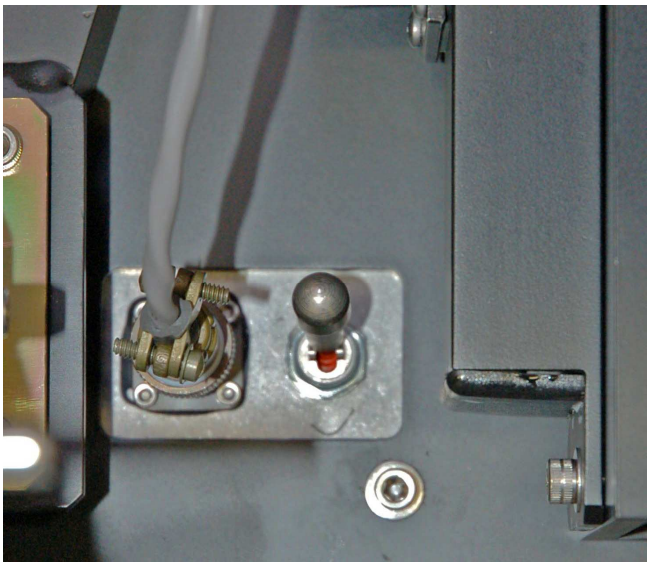


Figure 4-3.11: Tilt switch toggle on the bottom of the LHA.

To enable the tilt switches after all LHA are set at the proper incline and horizontal angles, place the "Tilt Switch Bypass" toggle on the PCU control panel to the down position.

Note that the purpose of the tilt switch is to automatically remove power from the PAPI if either LHA is off of its proper setting by more than ½ degree, for example if an LHA is displaced by a vehicle. The use of the tilt switches is optional.

4-4 Deployment of the Battery Box Assembly

Before operation of the BBA, first charge the batteries. Attach an external power cable to the BBA. Supply 200-400 VAC, 50/60 Hz to the external power cable. Allow 4.5 hours for the BBA to fully charge.

Carry the Battery Box Assembly (BBA) to a location near the LHA.

If the BBA is to be charged in place, connect a power cable to the AC input receptacle on the side of the BBA, and connect the other end to a source of AC power.

4-5 Deployment of the Power Control Unit

Carry the Power Control Unit (PCU) to the BBA.

The PCU is mounted on a BBA. Remove the pins that are stored in position in the U-channel near the top of an end of one of the BBA. The base flange of the PCU fits into the U- shaped trough near the bottom end of the BBA, and the extension on the flange at the top of the PCU fits into the U-channel on the top of the BBA. Reinstall the pins to hold the PCU in place with the two pins.

Figure 4-5.1: Power Control Unit (PCU) mounted on a Battery Box Assembly (BBA).

Connect a power/control cable (19 pin 36 ft cable) between the PCU and each LHA connect the output of each LHA to the next LHA in line..

Attach an radio power and control cables to the PCU.

Rotate the photocell shield so that the opening is pointing towards true north (in the northern hemisphere). If in the southern hemisphere point the opening towards the south.

Place the two-position on-off toggle switch on the PCU control panel to the "OFF" position.

Connect the battery power (3 pin 2 ft) cable between the PCU and the BBA.

Chapter 5. Power Control Unit Operating Procedures

5-1 Power Control Unit Switches

The Power Control Unit (PCU) has ten toggle switches on its control panel. The two switches on the left of the top row are for control. The third switch, from left-to-right, is for selection of the operating mode of the LHA, either visible signals or IR signals. The next five toggle switches are used to select the intensity step. The toggle switch on the left side, below the top row enables or disables autonomous photocell operation. The toggle switch on the bottom is to enable or disable the tilt switch.

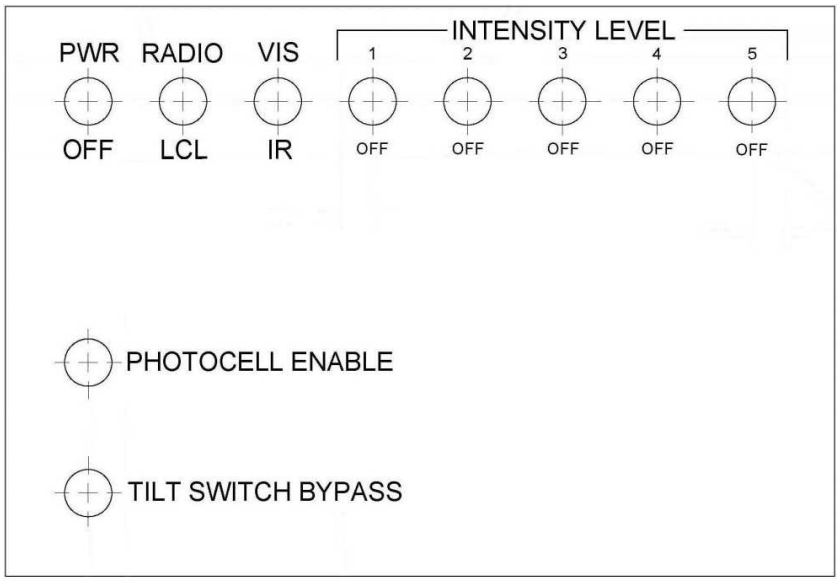


Figure 5-1.1: Power Control Unit (PCU) control panel layout.

The toggle switches on the top row are:

● The switch on the left-hand side marked with "PWR" turns the system on and off. When this switch is in the off position, no power is supplied to the LHAs and radio remote controller signals will not be received by the PCU.

● The local-radio switch determines if the PCU options are chosen by the remaining switches on the PCU control panel or by the radio remote controller. If this switch is in the "RADIO" (radio) position, then the PCU operation options are activated by the radio remote controller (supplied by Tactical Lighting Systems). If this switch is in the "LCL" (local) position, then the PCU options are selected by the positions of the switches to the right and below of this switch.

● The switch marked with “VIS/IR” determines if the visible (white/red) or infrared sources of the LHA’s are turned on when the local-radio switch is in the local control position ("LCL"). If the local-radio switch is in the radio ("RADIO") position, then the position of this switch is ignored.

● The intensity switch marked with “5” determines if the corridors of the LHAs are turned on the high setting (100% intensity) when in local control mode. If the local-radio switch is in the "RADIO" position, then the position of this switch is ignored.

● The intensity switch marked with “4” determines if the corridors of the LHAs are turned on the 20% intensity level when in local control mode. If the local-radio switch is in the "RADIO" position, then the position of this switch is ignored.

● The intensity switch marked with “3” determines if the corridors of the LHAs are turned on the 4% intensity level when in local control mode. If the local-radio switch is in the "RADIO" position, then the position of this switch is ignored.

● The intensity switch marked with “2” determines if the corridors of the LHAs are turned on the 0.8% intensity level when in local control mode. If the local-radio switch is in the "RADIO" position, then the position of this switch is ignored.

● The intensity switch marked with “1” determines if the corridors of the LHAs are turned on the lowest setting (0.16% intensity) when in local control mode. If the local-radio switch is in the "RADIO" position, then the position of this switch is ignored.

The controls on the bottom of the PCU control panel are:

● The switch marked with “PHOTOCELL ENABLE” determines if the photocell is used to switch the intensity high intensity, for daylight flight operations, or step 3 for night flight operations. If the photocell switch is in the "ON" position, then the intensity of the LHA are set by the ambient light intensity (i.e. the photocell is the dominant control), 100% intensity level for day and 4% intensity level for night. **When the photocell switch in the PCU is in the "ON" position, the mode switches in the PCU are ignored.**

● The toggle switch marked "Tilt Switch Bypass" is used to defeat the tilt switch cut-off operations without the use of the tilts switch such as initial set up, rapid ops, or to use the system with a damaged or inoperative tilt switch. When the "Tilt Switch Bypass" toggle is in the down position, the tilt switch is enabled. When the tilt switch is enabled, the PCU will turn off all power to all LHA if any LHA becomes misaligned in incline angle of nominal ±0.5 degree. If issues arise with the operation of the tilt switches, use the tilt switch bypass to continue to operate the PAPI system by placing the "Tilt Switch Pass" toggle on the PCU control panel in the up (disabled) position.

5-2 Power

The CT-LED-PAPI operates on nominal 24VDC and uses 280 W at the high visible (daytime) mode. The LHA receive 24 VDC power from the PCU.

WARNING

DO NOT connect the Power Control Unit (PCU) directly to the DC output of a generator or any unregulated power source. Connecting to an unregulated source may result in damage to the PCU and LHA.

WARNING

Make sure that the power toggle switch is in the "OFF" position when power is applied to the PCU. DO NOT connect power to the Power Control Unit (PCU) control panel power switch to the "PWR" position. Failure to do so may result in damage the power sources or the PCU.

The Battery Box Assemblies (BBA) supply 24 VDC to the PCU. The batteries in the BBA can be charged with 200 to 400 VAC, 50/60 Hz. The current draw is dependent upon the AC voltage. At 200 VAC the peak current draw is 7 A and at 400 VAC the peak current draw is 4 A. The nominal current draws during charging are smaller. The batteries in the BBA can also be charged from solar panels.

5-3 Power Control Unit Manual Operation

For manual operation from the Power Control Unit (PCU) control panel, the radio-local toggle switch must be in the local ("LCL") position.

Note that if all of the intensity level switches are in the off position, then no signal emanates from the LHA. Also note that if the radio-local toggle switch on the PCU is in the radio ("RADIO") position, then the operating mode is selected from the Tactical Lighting Systems radio remote control transmitter.

5-3.1 To operate in visible mode with the PCU

(1) Before operating the PCU, make sure that the power switch is in the "OFF" position.
(2) Set the local-radio toggle switch to the local ("LCL") position.
(3) Set all of the intensity step toggle switches on the PCU control panel to the "OFF" position.
(4) Set the Visible-IR toggle switch on the PCU control panel to the “VIS” position.
(5) Move the power toggle switch on the PCU to the "PWR" position.
(6) Set one of the intensity step toggle switches to its ON position. Step 1 is the lowest intensity and step 5 is the highest intensity. If more than one of the intensity step toggle switches is in the ON position, then the LHA will operate at the highest step that is switched to the on position.

5-3.2 To operate in IR (NVG) mode with the PCU

(1) Before operating the PCU, make sure that the power switch is in the "OFF" position.
(2) Set the local-radio toggle switch to the local ("LCL") position.
(3) Set all of the intensity step toggle switches on the PCU control panel to the "OFF" position.
(4) Set the Visible-IR toggle switch on the PCU control panel to the “IR” position.
(5) Move the power toggle switch on the PCU to the "PWR" position.
(6) Set one of the intensity step toggle switches to its ON position. Step 1 is the lowest intensity and step 5 is the highest intensity. If more than one of the intensity step toggle switches is in the ON position, then the LHA will operate at the highest step that is switched to the on position.

Chapter 6. Remote Control Operating Procedures

In order for a Power Control Unit (PCU) to receive and process the signals for radio remote control, the power switch of the PCU must be in the “PWR” position and the radio-manual toggle switch on the PCU control panel must be in the radio ("RADIO") position.

See the Tactical Lighting Systems manual for remote control set up and procedures.

Chapter 7. Preparation for Movement

The following procedure is used to prepare the PAPI-266 for movement:

Power Control Unit (PCU)
(1) Place the on-off toggle switch on the PCU control panel to the “Off” position.
(2) Remove the cables from the PCU to the four LHA.

Battery Box Assembly (BBA):
(1) Turn off the power from the power source.
(2) Unplug the cables from the power sources.
(3) Remove the cable from the BBA to the PCU.
(4) Remove the PCU from the BBA (see section 4-4).

Light Housing assemblies (LHA):
(1) Remove the tilt switch assembly. Secure the mounting screws back in the tilt switch bracket.
(2) Remove the shield from the top of the weather cover by twisting four 1/4-turn fasteners counterclockwise to release. Place the shield in front of the lenses. Lock the shield in place by pushing the 1/4-turn fasteners into their respective holes and turning clockwise until they lock.
(3) Remove the ground stakes and tie-down straps that hold the Light Housing Assemblies (LHA) in place.
(4) Loosen each of the lock nuts from the turnbuckles on each of the LHA legs.
(5) Turn the turnbuckles on each of the six legs to minimize the length of thread that is exposed.
(6) Fold up each of the legs of the LHA by removing the lock pin, folding the foot under the LHA, and replacing the lock pin.

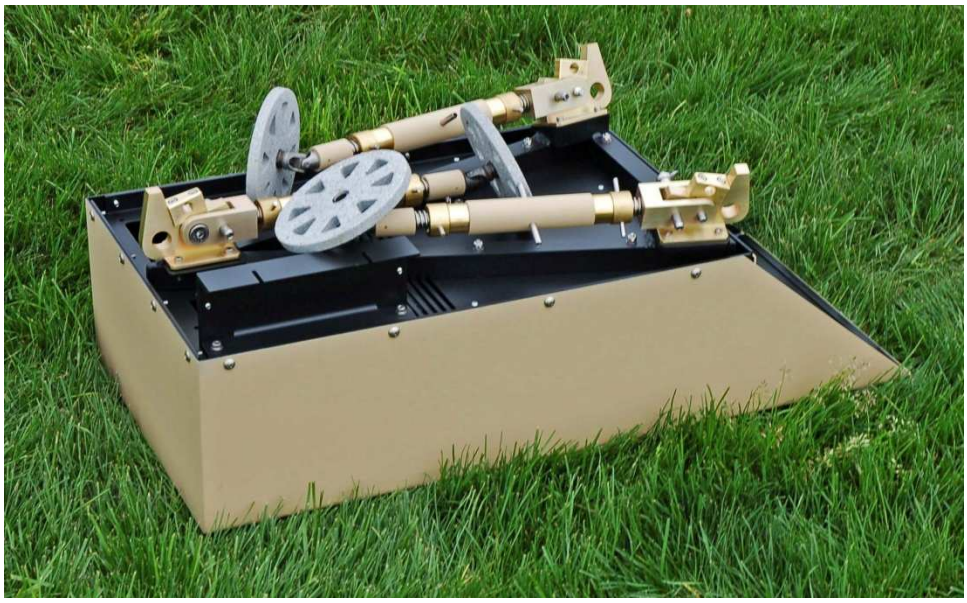


Figure 7-0.1: Legs folded under a Light Housing Assembly (LHA).

The LHA are designed to be transported in the horizontal position with the legs folded up and locked underneath. In this position the weight of the LHA is supported by the three extensions that protrude downward from the leg mounts.

Store the inclinometer in its protective plastic case.

If the system is to be transported, replace the LHA components in the shipping containers. Replace the other components in their storage locations on the system trailer.

Place the cover on the shipping container and secure the latches.

Chapter 8. Operation Under Unusual Conditions

8-1 Unusual Environment and Weather

a. Below Freezing Temperatures
   (1) If required, clear frost from the exit aperture lenses by wiping them with a clean, soft cloth.
   (2) Recalibrate the digital inclinometer.

b. Soft Ground and with optional rapid deployment legs
   (1) Check the level, angle, and aim of the LHA daily.

c. Snow
   (1) Clear snow away from the front of the LHA and PCU. If required, wipe the exit aperture lenses with a clean, soft cloth to remove any snow.

d. Heavy Rain
   (1) If required, clear residual water drops from the exit aperture lenses by wiping them with a clean, soft cloth.

e. Dust storm
   (1) Clear dust from the exit aperture lenses by wiping them with a clean, soft cloth.

8-2 Emergency Procedures

(1) Place the on-off toggle switch on the Power Control Unit (PCU) control panel to the "OFF" position.
(2) Turn off the power from the power source.
(3) Unplug the cable from the BBA to the PCU.
(4) Unplug the cable from the Battery Box Assembly (BBA) to the Solar Array Modules.
(5) Unplug the cables from the Solar Array Modules.

Chapter 9. Maintenance

9-1 Checks Before and After Deployment

9-1.1 Preliminary

Move the Light Housing Assemblies (LHA) to a work area.

If the LHA are dirty, rinse the LHA by spraying with clean water and wiping off any debris with a cloth.

Set up the LHA and the Power Control Unit (PCU) as explained in Chapter 4, except that they do not need to be set up next to the runway, do not need to be aligned in any particular direction, and do not need to be set level in the side-to-side direction or at any particular tilt angle.

Clean the exposed surfaces of the lenses according to the instructions in Section 9-4.

Connect power to the PCU according to Section 5-2.

9-1.2 Manual Operation

Turn the radio-local toggle switch on the PCU to the local ("LCL") position, see Section 5-3. Place the "Tilt Switch Bypass" toggle on the PCU to the disabled (up) position.

Operate the LHA in full intensity visible mode (step 5) according to Section 5-3.1.

- Stand in front of an LHA and place a diffuse reflective surface in front of the weather cover so that you can see the reflection of the beams. CAUTION: DO NOT STARE INTO THE BEAMS. The surface can be a piece of paper, cardboard, or even your clothing. Check that white light is emitted from the top row and red light is emitted from the bottom row.
- Note the intensity of the light on the reflective surface. Move the intensity step 5 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 4 toggle switch to the ON (“4”) position. The intensity of the white and red beams should now be 20% of the step 5 intensity.
- Move the intensity step 4 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 3 toggle switch to the ON (“3”) position. The intensity of the white and red beams should now be 4% of the intensity before the positions of the toggle switches were changed.
- Move the intensity step 3 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 2 toggle switch to the ON (“2”) position. The intensity of the white and red beams should now be 0.8% of the step 5 intensity.
- Move the intensity step 2 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 1 toggle switch to the ON (“1”) position. The intensity of the white and red beams should now be 0.16% of the step 5 intensity.

In order to check the operation of the IR LED sources, the work area must be dark and NVG must be used to view the beams. Operate the LHA in full intensity (step 5) IR mode according to Section 5-3.2.

- Stand in front of an LHA and place a diffuse reflective surface in front of the weather cover so that you can see the reflection of the beams. CAUTION: DO NOT STARE INTO THE BEAMS. Look at the reflective surface with NVG to verify that the steady signal is emitted from the top row and that a flashing signal is emitted from the bottom row.
- Move the intensity step 5 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 4 toggle switch to the ON (“4”) position. The intensity of the steady and flashing IR beams should now be 20% of the step 5 intensity.
- Move the intensity step 4 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 3 toggle switch to the ON (“3”) position. The intensity of the steady and flashing IR beams should now be 4% of the intensity before the positions of the toggle switches were changed.

- Move the intensity step 3 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 2 toggle switch to the ON (“2”) position. The intensity of the steady and flashing IR beams should now be 0.8% of the step 5 intensity.
- Move the intensity step 2 toggle switch on the PCU control panel to the "OFF" position, then move the intensity step 1 toggle switch to the ON (“1”) position. The intensity of the steady and flashing IR beams should now be 016% of the step 5 intensity.

Check the operation of the other LHA in the same manner as for the first LHA in the preceding two paragraphs.

9-1.3 Radio Remote Control Operation

Turn the radio-manual toggle switch on the PCU to the radio ("RAD") position. Place the "Tilt Switch Bypass" toggle on the PCU to the disabled (up) position. Follow the instructions in the Tactical Lighting Systems manual for testing.

9-2 Maintenance While Deployed

During deployment the only required maintenance under normal operating conditions is a weekly cleaning of the outer surfaces of the lenses of each of the Light Housing assemblies (LHA). The cleaning procedure is described in Section 9-4. The lenses should also be cleaned after a storm.

During deployment the only required maintenance under normal operating conditions is a weekly cleaning of the solar panels by spraying with clean water and wiping off any debris with a soft cloth. The solar panels should also be cleaned after a storm.

9-3 Periodic Preventative Maintenance

No periodic preventive maintenance is required.

To maintain readiness, it is recommended that the procedures in Section 9-1 should be performed every three months.

9-4 Cleaning the Lenses of a Light Housing Assembly

The front surfaces of the lenses of a Light Housing Assembly (LHA) are reached through the front, under the weather cover. Use a clean, soft lint-free cloth or lens tissue to clean the outer surfaces of the lenses. Reach in to clean the lenses. It is best to wipe with a downward motion, and lifting the cloth from the lens surface before repeating the wiping motion. In this way, the dirt and debris is accumulated at the bottom of the lens where it has no effect on the beam. Be careful to apply only light pressure as often the grit on the lens is hard and sharp and will scratch the surface of the lenses.

Clean water may be sprayed on the outer surfaces of the lenses. Then use a clean, soft lint-free cloth or lens tissue to clean the outer surfaces of the lenses and wipe the residue water off of the lenses.

If the front surfaces of the lenses are very dirty, lens cleaner fluid may be used. Spray or pour a small amount of the lens cleaning fluid on some clean lens tissue of piece of soft cloth, then wipe the lenses in a downward motion, as explained previously. Take another piece of clean, dry lens tissue or soft cloth and wipe the residual lens cleaner fluid off of the lenses with the same downward motion as discussed previously. Note that if lens cleaning fluid is not available, then clean water may be used.

NOTE
It is important not to scratch the outer surface of the lenses or leave residue that attracts dust or dirt.

CAUTION
Be careful to apply only light pressure as often the grit on the lens is hard and sharp and will scratch the surface of the lenses.

CAUTION
Do not use standard commercial glass window cleaners on the exit windows. While the lens itself is hard, the outer surface is coated and the cleaner may remove or scratch the coating. If necessary, use a standard lens cleaning fluid.

Supplies Needed:

clean, soft lint-free cloth
clean water
lens cleaning fluid

Chapter 10. Parts Replacement

It is best if replacement of any part is performed in a clean, dry environment. However if necessary, part replacement can be performed while the CT-LED-PAPI is deployed.

For greatest safety all power to the PCU should be disconnected, and the LHA cable should be disconnect at the PCU. However, parts replacement in a Light Housing Assembly (LHA) can be performed with the power toggle switch on the Power Control Unit (PCU) control panel to the "OFF" position. In this case, it is recommended that the power toggle switch on the Power Control Unit (PCU) control panel be taped to the "OFF" position so that power cannot be inadvertently applied to the Light Housing Assemblies (LHA) and a tag be placed on the outside of the PCU to indicate that work is underway.

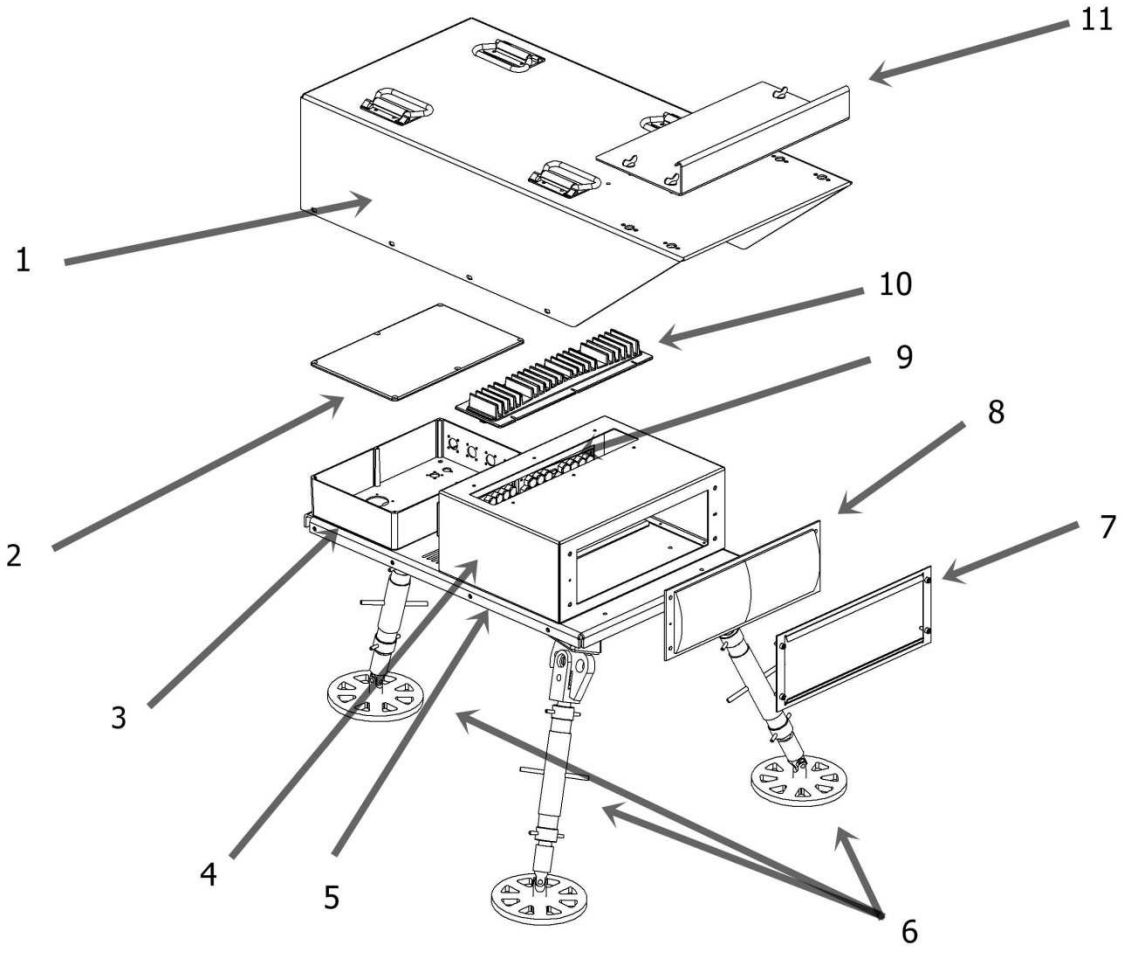


Figure 10-0.1: Exploded view of the PAPI with the parts numbered:

1 - weather cover, CH6514; **2- electronic enclosure top, CH6570;**
3- electronic enclosure bottom, CH6526; **4- optics enclosure, CH6521;**
5- base plate, CH6513; **6- adjustable legs (3), CH6518;**
7- front bezel, CH6461; **8- primary lens assembly, CH6454;**
9-LED module red, CH6399; **10- LED module white, CH6596;**
11- deflector/lens cover, CH6516

10-1 Removal of LHA Weather Cover

Remove four machine screws along the bottom of the rear panel of the LHA weather cover, and five machine screws along the bottom of both sides of the weather cover. Save these screws in a clean, safe place.

Slide the weather cover back slightly, then lift the weather cover straight up until it clears the optical assembly. Set the weather cover away from the remainder of the LHA.

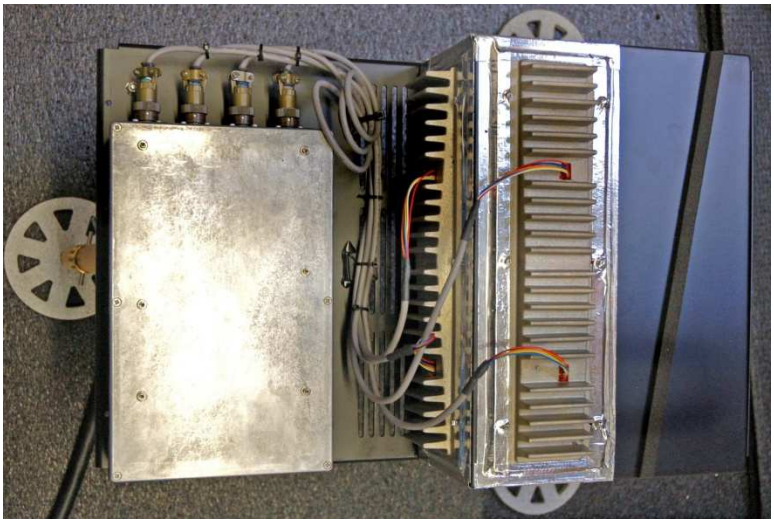


Figure 10-1.1: PAPI with the weather cover removed. The front of the PAPI is on the right. The power circuit board is located in the aluminum enclosure at the rear of the PAPI.

Tools Needed:

Phillips screwdriver

10-2 Replacement of White / Steady IR LED Module

Place the power toggle switch on the Power Control Unit (PCU) control panel to the "OFF" position, see Section 5-1. Disconnect the LHA cable at the PCU. For greatest safety power to the PCU should be disconnected.

Remove the LHA weather cover by following the procedure in Section 10-1.

The white LED modules (meaning modules with both the white light LEDs and steady IR LEDs) are located on the top row of the optical head assembly. Disconnect the cables to the module that is to be replaced.

Figure 10-2.1: The white LED modules are located on the top row of the optical head assembly, and the red modules are located on the bottom row of the optical head assembly.

Remove the aluminum tape that is a seal around the white LED module that is being replaced. Mark the position, relative to the optical head, of the LED module, so that the replacement module can be placed in the same position. Use a 3/32-inch hex wrench to loosen the six machine screws that hold the white LED module to the optical head. Remove all of these screws. Hold on to the LED module while removing the screws. Store the screws in a clean, dry place.

Separate the LED module from the optical head assembly by lifting it upwards. Remove the gasket (if there is a replacement gasket available).

Figure 10-2.2: Gasket on the optical head.

Obtain a replacement white LED module and gasket.

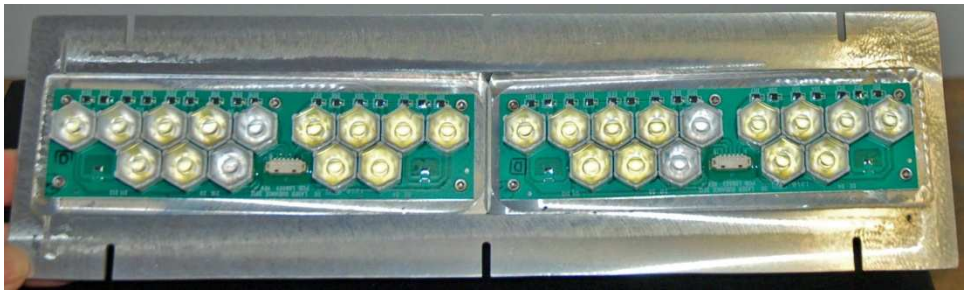


Figure 10-2.3: White LED module from LED side.

Replace the gasket.

Place the white LED module against the optical head assembly so that all six slots are aligned with their corresponding screw holes. Replace the six socket head cap screws that hold the LED module to the optical head assembly. Do not tighten yet. Move the LED module up and down until it is in the same location as the LED module that was removed. Note that the location of the original LED module was marked before the screws were loosened. Tighten these screws with a 3/32-inch hex wrench. Use aluminum tape to seal around the white LED module.

Figure 10-2.4: Aluminum tape seal on the white LED module.

Connect the cables. Note that the connector is keyed so that it cannot be inserted in an incorrect orientation.

Perform the checks in Section 9-2.1 to ensure that the module is functioning properly.

Replace the weather cover by reversing the steps in Section 10-1.

Tools Needed:

phillips screwdriver
3/32-inch hex wrench

Spare Part Needed:

white LED module, CH6596
gasket for LED module, CH6520
aluminum tape

10-3 Replacement of Red / Flashing IR LED Module

Place the power toggle switch on the Power Control Unit (PCU) control panel to the "OFF" position, see Section 5-1. Disconnect the LHA cable at the PCU. For greatest safety power to the PCU should be disconnected.

Remove the LHA weather cover by following the procedure in Section 10-1.

The red LED modules (meaning modules with both the red light LEDs and the flashing IR LEDs) are located on the bottom row of the optical head assembly. Disconnect the cables to the module that is to be replaced.

Remove the aluminum tape that is a seal around the red LED module that is being replaced. Mark the position, relative to the optical head, of the red LED module, so that the replacement module can be placed in the same position. Use a 3/32-inch hex wrench to loosen the six screws that hold the white LED module to the optical head. Remove all of these screws. Hold on to the LED module while removing the screws. Store the screws in a clean, dry place.

Separate the LED module from the optical head assembly. Remove the gasket (if there is a new gasket available).

Obtain a replacement red LED module.

Replace the gasket.

Place the red LED module against the optical head assembly so that all six slots are aligned with their corresponding screw holes. Replace the six socket head cap screws that hold the LED module to the optical head assembly. Do not tighten yet. Move the LED module up and down until it is in the same location as the LED module that was removed. Note that the location of the original LED module was marked before the screws were loosened. Tighten these screws with a 3/32-inch hex wrench. Use aluminum tape to seal around the red LED module.

Connect the cables. Note that the connector is keyed so that it cannot be inserted in an incorrect orientation.

Perform the checks in Section 9-2.1 to ensure that the module is functioning properly.

Replace the weather cover by reversing the steps in Section 10-1.

Tools Needed:

phillips screwdriver
3/32-inch hex wrench

Spare Part Needed:

red LED module, CH6399
gasket for LED module, CH6520
aluminum tape

10-4 Replacement of an LHA Power Circuit Board

Place the power toggle switch on the Power Control Unit (PCU) control panel to the “OFF” position, see Section 5-1. Disconnect the LHA cable at the PCU.

Remove the LHA weather cover by following the procedure in Section 10-1.

Remove the six countersunk-head screws from the top of the aluminum enclosure that is mounted in the rear starboard side of the LHA base plate. Remove the top cover of the box. Store the screws and the cover in a clean, dry place.

Remove the six nuts that hold the power circuit board to the stand-offs. Store the nuts in a clean, dry place. Mark the Molex connectors to indicate the location and orientation relative to the power control board. Carefully lift the circuit board and remove the Molex connectors from the power control board.

Obtain a replacement LHA power control board.

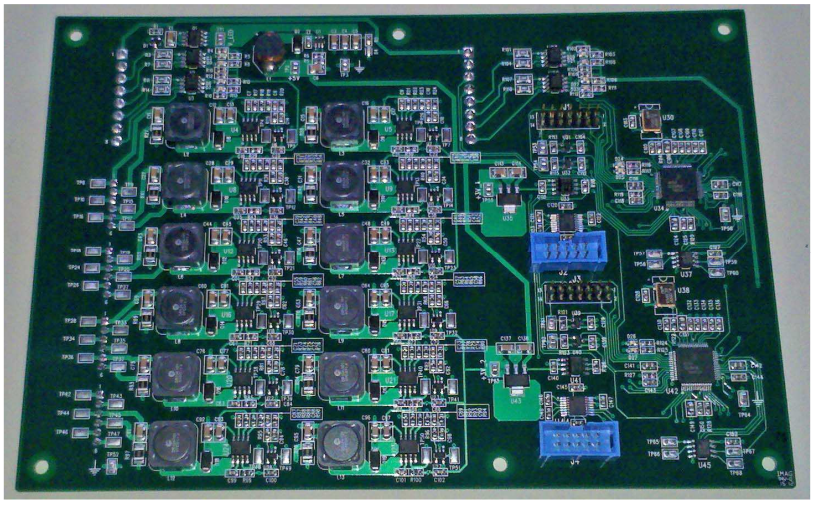


Figure 10-4.1: LHA Power Control Board

Insert the Molex connectors in the same location and orientation on the power control board. Make sure that the Molex connectors are fully engaged to the power control board.

Carefully replace the power control board into the box and secure the power control board to the standoffs with the nuts.

Replace the cover of the box and secure with its screws.

Replace the weather cover by reversing the steps in Section 10-1.

Tools Needed:

#1 phillips screwdriver
1/4-inch wrench or 1/4-inch nut driver

Spare Part Needed:

LHA power control board, CH6571

10-5 Replacement of Batteries in the Battery Box Assembly

Place the power toggle switch on the Power Control Unit (PCU) control panel to the "OFF" position, see Section 5-1.

Disconnect the input AC power cord to the Battery Box Assembly (BBA), if it is connected. Disconnect the solar Array modules to BBA cable at the BBA.

Disconnect the 24 VDC cable from the BBA to the PCU.

Open the lid of the BBA by unlatching the 4 latches around the perimeter of the BBA lid.

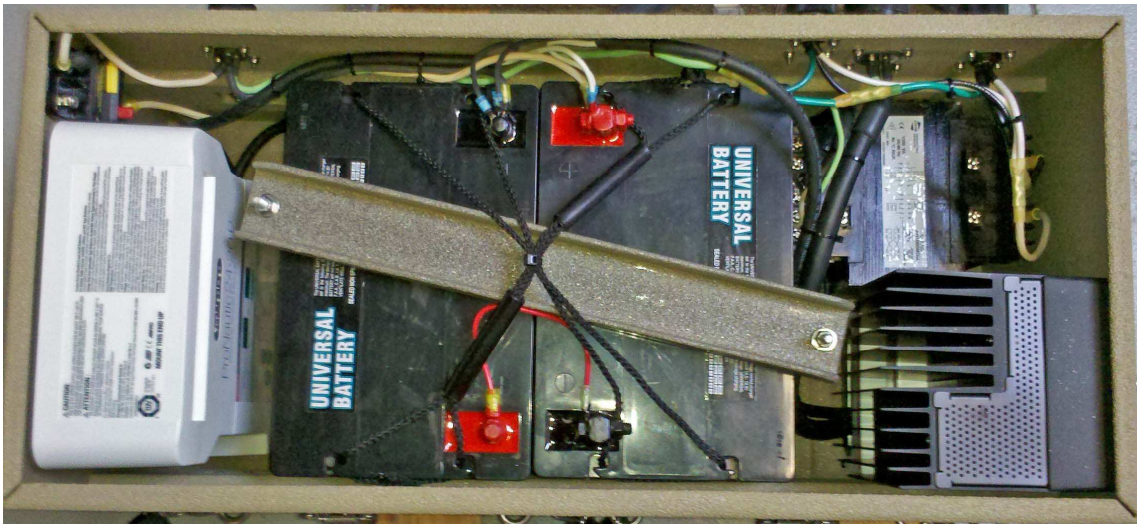


Figure 10-5.1: Looking inside the Battery Box Assembly from the top. The circuit breaker is in the upper left corner of the picture. The battery charger is on the left. The two batteries are in the middle. A 2:1 step-down AC transformer is in the upper right of the picture. The charge controller for the solar array modules is in the lower right.

Carefully remove the black cover from the ground side terminal of the batteries. Using both a 1/2-inch and 9/16-inch wrench, loosen the bolt that holds the cable to the battery terminal. **Be very careful not to touch the wrenches to any other conductive surface.** When the cable is free, cover it with an insulating material and pull it away from the battery terminal. Remove the bolt and store it in a clean, dry place. Cover the battery terminal with an insulating material, so that no cables or tools are able to touch the battery terminal.

Carefully remove the black cover from the other battery. Using both a 1/2-inch and 9/16-inch wrench, loosen the bolt that holds the cable to the battery terminal. **Be careful not to touch the wrenches to any other conductive surface.** When the cable is free, cover it with an insulating material and pull it away from the battery terminal. Remove the bolt and store it in a clean, dry place. Cover the battery terminal with an insulating material, so that no cables or tools are able to touch the battery terminal.

Carefully remove the red cover from the positive terminal of the batteries. Using both a 1/2-inch and 9/16-inch wrench, loosen the bolt that holds the cable to the battery terminal. Be careful not to touch the wrenches to any other conductive surface. When the cable is free, cover it with an insulating material and pull it away from the battery terminal. Remove the bolt and store it in a clean, dry place. Cover the battery terminal with an insulating material, so that no cables or tools are able to touch the battery terminal.

Carefully remove the red cover from the positive terminal of the other battery. Using both a 1/2-inch and 9/16-inch wrench, loosen the bolt that holds the cable to the battery terminal. Be careful not to touch the wrenches to any other conductive surface. When the cable is free, cover it with an insulating material and pull it away from the battery terminal. Remove the bolt and store it in a clean, dry place. Cover the battery terminal with an insulating material, so that no cables or tools are able to touch the battery terminal.

Loosen the battery hold down clamps with a 7/16-inch wrench. Remove the nuts and store in a clean.dry place. Remove the battery hold down frame. Remove the battery hold down clamps, which have a hooked end.

Note the orientation of the batteries in the BBA. Lift the batteries out of the BBA.

Obtain replacement batteries. Note that both batteries should be replaced at the same time.

Place the batteries in the BBA in the same orientation as the original batteries.

Replace the battery hold-down clamps, battery hold down frame, and the battery hold down clamp nuts. Tighten the nuts so that the battery do not move, but do not over tighten.

Connect the cable between the two batteries using the bolts and nuts that held the cable to the battery terminals. Be sure that the cable is oriented so that the red cover is on the positive terminal of one battery and the black cover is on the negative terminal of the other battery. Slide the battery terminal covers over the terminals.

Connect the negative-side cable with the black terminal cover to the negative side of the batteries. Slide the black cover over the terminal.

Very carefully attach the positive side cable with the red terminal cover to the positive terminal of the battery. **Be very careful not to let the cable or the wrenches touch any conductive surface.** Slide the red cover over the battery terminal.

Replace the BBA lid and secure the latches.

Tools Needed:

7/16-inch wrench
1/2-inch wrench
9/16-inch wrench

Spare Parts Needed:

Two 12V, 75 AH, AGM batteries

Chapter 11. Troubleshooting

In the event that the PAPI in not functioning properly, the first action is to ensure that power is being supplied, that the switches of the Power Control Unit (PCU) are set properly, and all of the cables are attached properly. See Chapters 4, 5, and 6.

11-1 Power Train

If there is no light emitted from all Light Housing assemblies (LHA), first check to see if the local-radio toggle switch on the PCU control panel is in the local ("LCL") position and that all of the intensity switches are in the off position. If this is the case, then no light should emanate from the LHAs. Switch the step 5 toggle switch to the ON ("5") position and check for light from the LHAs. If the local-radio toggle switch is in the radio ("RADIO") position, then change the local-radio toggle switch to the local ("LCL") position and the step 5 toggle switch to the ON ("5") position.

If there is no light emitted from all Light Housing assemblies (LHA), disable the tilt switches by placing the "Tilt Switch Bypass" toggle on the PCU control panel to the disabled (up) position. If light is now emitted from the LHA, realign the LHA according to Section 4-3. If there is still no light emitted from the LHA, then check for power along the power train.

Determine if the battery bank is charged. Connect the battery charging cord to the Battery Box Assemblies (BBA) and connect to a known working source of appropriate AC power. If the PAPI operates, then the batteries were discharged. Follow the procedures in Section 4-4. Allow sufficient time for the batteries to charge.

Remove the BBA to PCU cables from the BBA. Check the voltage at the output connector of each BBA. It should be a nominal 24 VDC, which can be between 22 and 28.8 VDC, depending upon the state of charge. If the voltage is zero, then open the top of the battery box and check the circuit breaker. Reset the circuit breaker and make sure that its switch is in the on position.

Connect the BBA to PCU cable to each BBA and remove the BBA to PCU cable from the PCU. Check the voltage at the end of the cable. The voltage should be nominal 24 VDC. If there is voltage at the BBA and not at the end of the cable, then the wrong cable end was connected to the BBA, the connector was not fastened properly, or the cable is defective and must be replaced.

Plug the BBA to PCU cables into the PCU. Operate the PCU in manual mode according to the instructions in Section 5-3. Check to be sure that the radio-local switch on the PCU control panel is in the local "LCL" position. If none of the LHAs are functioning in any mode, then disconnect the PCU to LHA cables and check the voltage across pins A and B of the connector. The voltage should be nominal 24 VDC. If there is no voltage out of the PCU, check that the BBA to PCU cables are connected properly. If still no voltage, return the PCU for repair.

Connect the PCU to LHA cables to the PCU, and remove the PCU to LHA cables from the LHA. Check the voltage across pins A and B. The voltage should be nominal 24 VDC. If there is voltage at the PCU and not at the end of the cable, then the wrong cable end was connected to the PCU or the cable is defective and must be replaced.

Reconnect the PCU to LHA cables.

11-2 LHA Power Control Board

If three LHAs operate properly and one LHA does not emit any light and there is voltage at the PCU to LHA cable to the non-functioning LHA, then the most likely cause is failure of the LHA power control board.

Place the power toggle switch on the Power Control Unit (PCU) control panel to the “OFF” position, see Section 5-1. Disconnect the LHA cable at the PCU.

Remove the LHA weather cover by following the procedure in Section 10-1.

Check all of the connections to the receptacles on the power control board enclosure

Remove the six countersunk-head screws from the top of the aluminum enclosure that is mounted in the rear starboard side of the LHA base plate. Remove the top cover of the box. Store the screws and the cover in a clean, dry place.

Check all of the connections to the LHA power control board.

If all of the connections are good, then the most likely cause is failure of the LHA power control board. Replace the power control board in the non-functioning LHA.

11-3 White / Steady IR LED Modules

If three LHA operate properly and the other LHA does not emit any white light from the white LED module (meaning module with both the white light LEDs and steady IR LEDs) and there is power to the non-functioning LHA, remove the weather cover according to the instructions in Section 10-1. Check that the connector to the non-functioning white LED module is connected properly. If the white LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

If one side of a white module does not emit any white light, then check the connector to the non-functioning side to see that is it connected properly. If the white LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

Note that failure of up to 25% of the white LED sources on the white module of an LHA is allowed before the LHA must be removed from service. The LED sources can be seen by looking into the LHA through the front lenses with the LHA set at the lowest intensity level, step 1.

If the white LED modules do not change intensity levels, but still emit white light in one of the modes, then return the PCU for repair.

If three LHA operate properly and the other LHA does not emit any steady IR light from one of the white LED modules and there is power to the non-functioning LHA, remove the weather cover according to the instructions in Section 10-1. Check that the connector to the non-functioning white LED module is connected properly. If the white LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

If one side of a white module does not emit any steady IR light, then check the connector to the non-functioning side to see that is it connected properly. If the white LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

If the white LED modules do not change IR intensity levels, but still emits IR light in one of the modes, then return the PCU for repair.

11-4 Red / Flashing IR LED Modules

If one LHA operates properly and the other LHA does not emit any red light from one of the red LED modules (meaning modules with both the red light LEDs and the flashing IR LEDs), remove the weather cover according to the instructions in Section 10-1 and first check that the connector to that LED module is connected properly. If the red LED module still does not function properly, then replace the LED module according to the instructions in Section 10-4. If that does not correct the problem, replace the LHA power control board according to the instructions in Section 10-6.

If one side of a red module does not emit any red light, then check the connector to the non-functioning side to see that is it connected properly. If the red LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

Note that failure of up to 25% of the LED sources on the combination of the two red modules in an LHA is allowed before the LHA must be removed from service. The LED sources can be seen by looking into the LHA through the front lenses.

If the red LED modules do not change from high (daytime) to low (nighttime) modes, but still emit red light in one of the modes, then return the PCU for repair.

If three LHA operate properly and the other LHA does not emit any flashing IR light from one of the red LED modules and there is power to the non-functioning LHA, remove the weather cover according to the instructions in Section 10-1. Check that the connector to the non-functioning white LED module is connected properly. If the red LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

If one side of a red module does not emit any flashing IR light, then check the connector to the non-functioning side to see that is it connected properly. If the red LED module still does not function properly, then replace the LED module. If that does not correct the problem, replace the LHA power control board.

If the red LED modules do not change IR intensity levels, but still emits IR light in one of the modes, then return the PCU for repair.

11-5 Tilt Switches

If there is no light emitted from all Light Housing assemblies (LHA) and there is power all along the power train according to the procedures in Section 11-1, disable the tilt switches by placing the "Tilt Switch Bypass" toggle on the PCU control panel to the disabled (up) position.

If light is now emitted from the LHA, check the incline of the LHAs according to Section 4-3. When the LHAs are all aligned within the specification, check that the tilt switches on each LHA are set to level. Check that the tilt switch toggles on the three LHAs closest to the PCU are pointing towards the front of the respective LHA and that the tilt switch toggle on the LHA that is at the end of the connection chain is in the position pointing towards the rear of that LHA.

Place the "Tilt Switch Bypass" toggle on the PCU control panel to the enabled (down) position. If there is no light emitted from all Light Housing assemblies (LHA), disable the tilt switches by placing the "Tilt Switch Bypass" toggle on the PCU control panel to the disabled (up) position.

11-6 Portable Solar Module

In the event that the Portable Solar Module is not functioning properly, the first action is to ensure that all of the cables are attached properly. See Chapter 4.

Disconnect the cable from the PAPI Battery Box Assembly (BBA) at the BBA. Check the voltages at the output receptacle of the BBA. It should be a nominal 24 VDC, which can be between 22 and 28.8 VDC, depending upon the state of charge.

If the voltage is zero, then open the top of the BBA box and check the circuit breaker, which is located on the side of the battery box. Reset the circuit breaker and make sure that its switch is in the on position.

If the voltage is below 24 VDC, charge the batteries (See Chapter 4). Repeat the output voltage measurement. If the voltage remains below 22 VDC, replace the batteries.

With the solar panels pointed toward the sun (or a suitable bright light source), check the voltage at the end of the cable from the solar panels. The voltage should be greater than 24 VDC, and as high as 47 VDC.

APPENDIX A

Limited Warranty

One-Year Limited Hardware Warranty

Carmanah Technologies warrants your portable airfield lighting product against defects in materials and workmanship for a period of one year from delivery. If Carmanah receives notice of such defects during the warranty period, CH will either, at its option, repair or replace products that prove to be defective. CH will make the final determination as to the cause or existence of the defect.

Products that have been repaired or replaced by Carmanah under the initial warranty will be warranted only for the balance of the warranty period on the originally supplied product.

Exclusions

The above warranty shall not apply to defects or damage resulting from: improper or inadequate maintenance by customer; customer-supplied interfacing; unauthorized modification; misuse; operation outside of the environmental specifications for the product; or improper site preparation and maintenance. This warranty does not extend to damage caused by negligent or improper handling in use, storage, or transportation, or to products from which the original identification markings or labels have been removed, defaced, or altered.

Transferability

This warranty is transferable from the original purchaser of this product to subsequent buyers, providing that proof of legal transfer is supplied to Carmanah before any warranty service is requested. Carmanah reserves the right to verify such transfer with the original purchaser before warranty service is performed.

Obtaining Warranty Service

To obtain warranty service, products must be returned to a service facility designated by Carmanah. Customer shall prepay shipping charges for products returned to CT for warranty service. Customer shall pay all shipping charges, duties, and taxes for products returned to Carmanah.

Carmanah may organize repair on-site at the option of the customer. Customer is responsible for travel charges and personnel labor expenses when on-site repair is requested. Customer shall pay travel charges and personnel labor expenses when on-site repair is requested.

Warranty Limitations

EXCEPT AS SPECIFICALLY STATED HEREIN, THERE ARE NO OTHER EXPRESSED OR IMPLIED WARRANTIES. WITHOUT LIMITING THE GENERALITY OF THE FOREGOING, THERE ARE NO IMPLIED OR EXPRESSED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Failure to Pay in Full

If the equipment has not been paid in full, then the Warranty is voided. Carmanah will not be under any obligation to make any warranty repairs.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT SHALL CARMANAH BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Obtaining Service During Warranty Period

If your product should fail during the warranty period, first follow the test procedures in the Operating Manual. Then contact Carmanah by telephone at 877-772-8877 (in the USA) or via email at info@carmanah.com to obtain a Return Authorization Number and shipping instructions. Before requesting a Return Authorization Number, please be prepared to furnish the following information: product model number and serial number; date of shipment/purchase; brief description of problem; name, telephone number, and email address of the person at your organization for further communication. Bring or ship (freight and insurance prepaid) the failed piece of equipment to: Carmanah. Shipping damage as a result of inadequate packaging is the customer's responsibility.

Customer has the option of requesting on-site repair, in which case customer shall pay all travel and personnel labor charges.

Service after Warranty Period

If your equipment should fail after the warranty period, follow the test procedures in the Operation Manual. Then contact Carmanah by telephone at 877-772-8877 or email at info@carmanah.com for details of the services available. Carmanah will repair, or make fully functional if original parts are no longer available, any product which it has manufactured. Customer shall pay for these repairs.

APPENDIX B: Inclinometer Instructions

Introduction

The Pro 3600 Digital Protractor is a revolutionary measuring tool that provides an immediate, digital reading of all angles in a 360° circle. The machined aluminum frame is a rigid, light weight, ultra-precise platform that allows the state-of-the-art sensor and its microprocessor circuit to provide unsurpassed accuracy throughout the Protractor's 360° range.

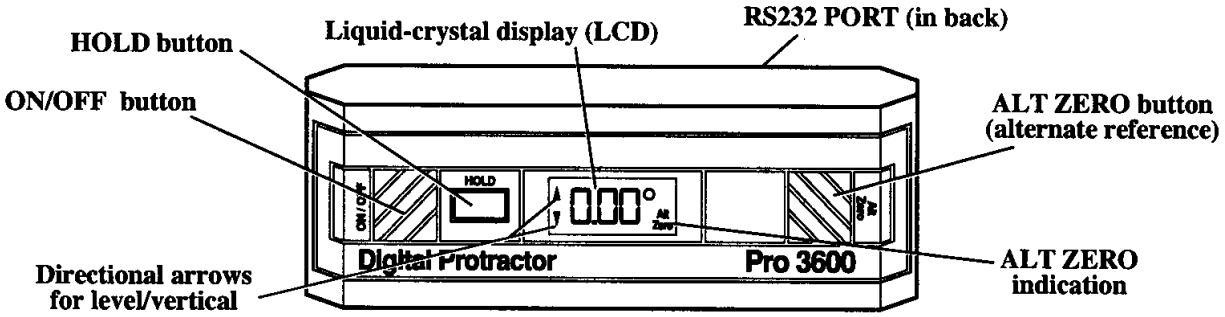
The Pro 3600 uses an innovative liquid filled angle sensor. As the protractor is moved, the liquid seeks a new position, resulting in changes in the electrical properties of the sensor. A microprocessor analyzes the changes and calculates the numbers seen on the display. The Pro 3600 also has an RS-232 compatible digital output which will interface with computers, data loggers and printers. This feature, along with the improved accuracy, high resolution and simple operation, makes the Pro 3600 a benchmark tool for years to come.

Feature Overview

The Pro 3600 operates normally in a standard reference mode where *level* is displayed as 0.00°. However, a new reference point for 0.00° can easily be established by pushing the ALT ZERO button. You can also "freeze" any displayed angle on the LCD by pushing the HOLD button.

The 360° range of the unit is organized into four 90° quadrants for display purposes. Display resolution is 0.01° near level (0.00° to 9.99°) and 0.1° at all other angles (10.0° to 90.0°).

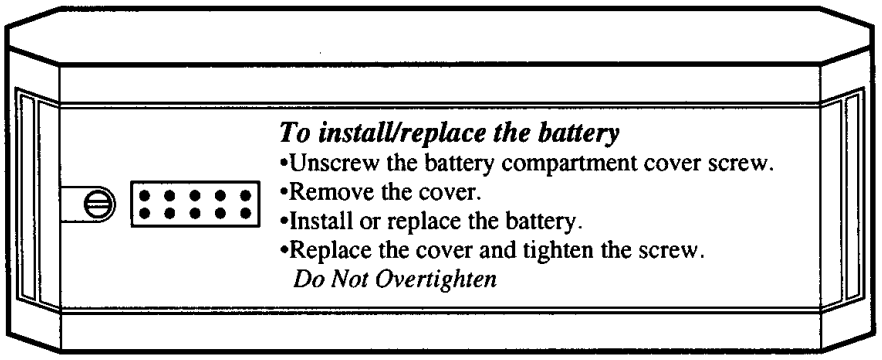
And the Pro 3600 does not need to be returned to the manufacturer or dealer for recalibration. By following the Superset® instructions in this booklet,you can test and recalibrate the Pro 3600 in just a couple of minutes on site and without any special fixtures.



Operating Instructions - Battery

The Pro 3600 is powered by a 9-volt battery. A new alkaline battery will provide 500 hours of use. A 9-volt lithium battery can be used for even longer life.

To extend battery life, the Pro 3600 shuts off automatically when left undisturbed for five minutes (to reactivate, push the ON/OFF button) unless there is activity on the serial port. Note: Hooking serial port pin 5 (REQ) to pin 9 (BATT+) disables the auto-power shutoff.. The Pro 3600 also indicates when the battery is low. Change the battery when the display alternately flashes "LO bAt" with angle measurements. (***NOTE***: The Pro 3600 does not display inaccurate angles due to a weak battery.)


To install/replace the battery
•Unscrew the battery compartment cover screw.
•Remove the cover.
•Install or replace the battery.
•Replace the cover and tighten the screw.
Do Not Overtighten

Operating Instructions - Angle Measuring

First, you must make sure your unit is reading accurately by using the test on pages 9-10. If the unit fails this simple test, you must recalibrate it using Superset® (pages 11-14).

To operate your Pro 3600, simply push the ON/OFF button; it will begin displaying angle readings immediately. Set the Pro 3600 on the surface to be measured and read the angle. (To get the most accurate reading, allow the unit to settle for 5 seconds before noting the angle.) The resolution will be one hundreths of a degree for ± 10° of level. The resolution will automatically change to tenths of a degree beyond these points.

When the unit is first turned on, the displayed angles will be in *standard reference mode* - level (true horizontal) is displayed as 0.00° and plumb (true vertical) is displayed as 90.0°. (An *alternate reference* point can be set easily if desired - see ALT ZERO.)

An arrow on the left side of the display will indicate which way to move the Pro 3600 to achieve level or plumb.

Between 0° and 44.9°, the arrow will point toward level. Between 45° and 89.9°, the arrow will point toward vertical (plumb).

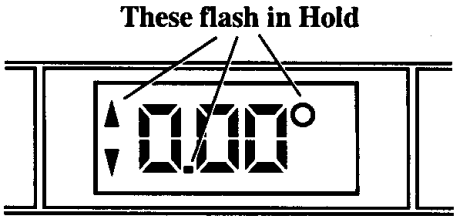
HOLD (temporarily "freezing" a reading on the display)

If you need to take a measurement with the Pro 3600 in an unreadable position, or if you need to temporarily lock in a reading while you record it, simply press the Hold button while measuring the angle. (Make sure the unit has been in position and still for 5 seconds.)

The readout will freeze and the decimal point, degree sign and an arrow on the left side of the LCD will flash.

To release, press the Hold button again.

Note: The Pro 3600 cannot be recalibrated (Superset®) nor can a new reference point be established (ALT ZERO) when the HOLD feature is engaged. The HOLD feature is disengaged automatically when the unit shuts off or is turned off.



ALT ZERO (Setting an alternate reference point)

ALT ZERO allows you to set any angle as a 0.00° reference point from which to take measurements.

To set an alternate reference point, place the Pro 3600 on the new surface and wait 5 seconds. Press the ALT ZERO button once. "**Alt** "will appear on the display, followed by "**-0-**". The Pro 3600 will then display angles using the new reference. ALT ZERO will appear in the lower right hand corner of the display as long as the Pro 3600 is in ALT ZERO mode.

Press ALT ZERO again to return to standard reference mode. The Pro 3600 also returns to standard reference when it is turned off or shuts off automatically.

NOTE: You cannot activate the ALT ZERO button when the Pro 3600 display is in HOLD.

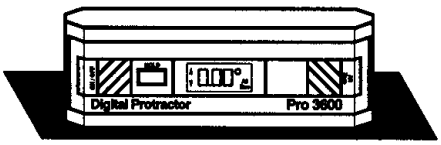
Recalibration

Like all measurement instruments the Pro 3600 must periodically be monitored for accuracy. The Pro 3600 should be tested daily with the simple procedure outlined below. If it is found to be out of calibration, it is easily recalibrated on site using Superset® - an eight-step procedure that realigns the unit through its entire 360° range and takes just a couple of minutes to perform. And Superset® doesn't require any special fixtures, tools, or expertise.

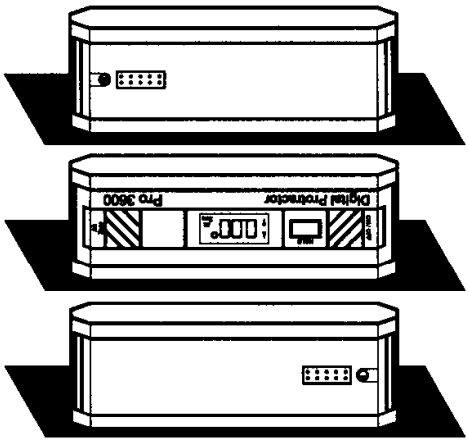
Accuracy Test

Perform this simple test each day before using the Pro 3600. Also perform it anytime the Pro 3600 has been dropped or is being used in an environment that varies more than 5° C (9° F) from the environment in which it was last calibrated. ***If your Pro 3600 fails this test, you must recalibrate it using Superset® before using the unit further to measure angles.***

- Position the Pro 3600 with the display facing you on a clean, flat horizontal surface. It doesn't have to be exactly level. Wait 10 seconds so the unit is completely settled and note the angle on the display.



- Rotate the unit end-for-end so the display is facing away from you. Be sure to set the Pro 3600 in exactly the same spot, and wait 10 seconds before reading the angle that's displayed.
- Now roll the unit toward you so that the display is facing you, but the lettering on the face of the unit is upside down. Wait 10 seconds, and note the angle on the display.
- Finally, rotate the unit end-for-end so the display is facing away from you (the lettering should still be upside-down). Wait 10 seconds and note the angle on the display.



- **If any of the four measurements varies from any other by more than 0.1°, you must recalibrate (Superset®) your unit before using it further.**

Superset®

Superset® recalibrates the Pro 3600 through its entire 360° range by electronically recording four horizontal and four vertical settings. It should be performed whenever the accuracy test shows a discrepancy of 0.1° or more.

How to Perform Superset®

Turn on the Pro 3600 and place it on a flat surface. You can use any horizontal surface within 10° of level and any vertical surface within 10° of plumb to perform Superset®. You must use the same surfaces throughout the entire process.

Note: Each time you reposition the Pro 3600 during Superset®, wait a minimum of 10 seconds before pressing the HOLD button to advance to the next step.

Starting Superset®

- Press and hold the HOLD and ALT ZERO buttons simultaneously. Keep them depressed for approximately three seconds.
- Release the buttons when the symbol **"SUP"** appears. A **"0"** within flashing brackets will then appear. These brackets are composed of four horizontal and four vertical segments.

  Note that as you proceed through the eight steps of Superset®, a new segment will hold steady after you complete each step.

"0" within flashing brackets

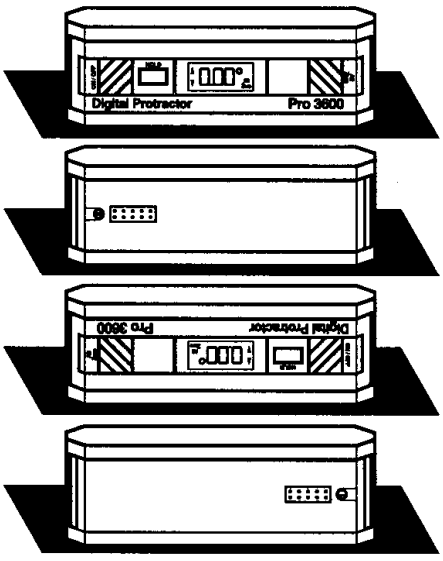
Superset® - Horizontal Settings

[1]
- Unit faces you and white lettering on face is right-side up.
- Align with an edge or line - wait 10 seconds.
- Press HOLD button until **[1]** appears.

[2]
- Rotate unit so it faces away from you, the lettering. should still be right-side up.
- Align with same edge or line - wait 10 seconds.
- Press HOLD button until **[2]** appears.

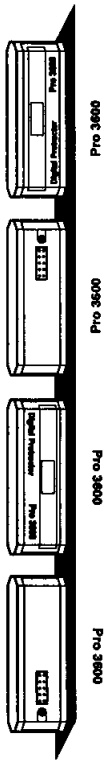
[3]
- Roll unit so it faces you, the lettering should now be upside-down.
- Align with same edge or line - wait 10 seconds.
- Press HOLD button until **[3]** appears.

[4]
- Rotate unit so it faces away from you, the lettering should still be upside-down.
- Align with same edge or line - wait 10 seconds.
- Press HOLD button until **[4]** appears.



You have completed one half of Superset® (continued on next page)

Superset® - Vertical Settings



[5]
- Place unit against vertical surface so it faces you, the lettering on the face ("Pro 3600, etc.) should read from bottom to top.
- Align with an edge or line - wait 10 seconds.
- Press HOLD button until **[5]** appears.

[6]
- Roll the unit so it faces away from you, the lettering should still read from bottom to top
- Align with same edge or line - wait 10 seconds
- Press HOLD button until **[6]** appears.

[7]
- Rotate unit end-for-end so it faces you, the lettering should now read top to bottom.
- Align with same edge or line - wait 10 seconds
- Press HOLD button until **[7]** appears.

[8]
- Roll the unit so it faces away from you, the lettering should still read top to bottom.
- Align with same edge or line - wait 10 seconds
- Press HOLD button. **[8]** will very briefly appear, followed immediately by regular angle measuring.

Your Pro 3600 has been Superset® back to manufacturer's spec's.

Canceling Superset®

You may cancel Superset® at any time during the process by turning the unit off.

Maintenance

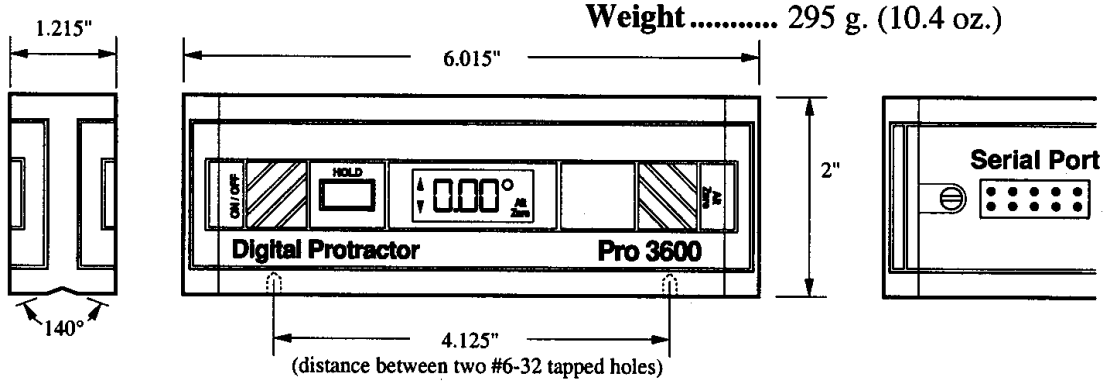
The Pro 3600 is designed to stand up to the rigors of industrial use. The following tips will ensure a long service life:

- Use the "end-for-end" accuracy test daily to make sure the unit is in calibration. If it is not, recalibrate it immediately with Superset®.
- Clean the Pro 3600 with mild liquid soap and a damp cloth. Never immerse in water.
- Do not use solvents directly on any of the Pro 3600 plastic surfaces.
- Store the Pro 3600 away from extreme temperature: Never below -20°C (-4°F) or above 65°C (149°F).

Pro 3600 Specifications

Range ..... 360° (90° x 4)
Resolution ..... 0.01° (0° to 9.99°)
0.10° (10° to 90°)
Accuracy ..... ±0.05° (0° to 10°)
±0.10° (80° to 90°)
±0.20° (10° to 80°)
Repeatability ..... ±0.05°
Cross Axis Error .. Minimal

Serial Port
Type ..... RS-232 Compatible
Connector ..... 10-pin, Rectangular
Supply Voltage ..... 9 V. Alkaline Battery
Battery Life ..... 500 hours typical
Temperature
Operating .. -5°C to 50°C (23°F to 122°F)
Storage ..... -20°C to 65°C
(-4°F to 149°F)
Weight ..... 295 g. (10.4 oz.)



APPENDIX C: Instructions for the Battery Charger in the Battery Box Assembly

The ProNautic P2420 battery charger is fully automatic with sequential multi-stage charging that provides electronically controlled charging, conditioning, and maintenance. This unit is designed for 100-240 VAC operation at 60 Hz and 50 Hz. **Note: there is a 2:1 step-down transformer in the Battery Box Assembly (BBA), so that the input voltage to the BBA is 200-400 VAC.**

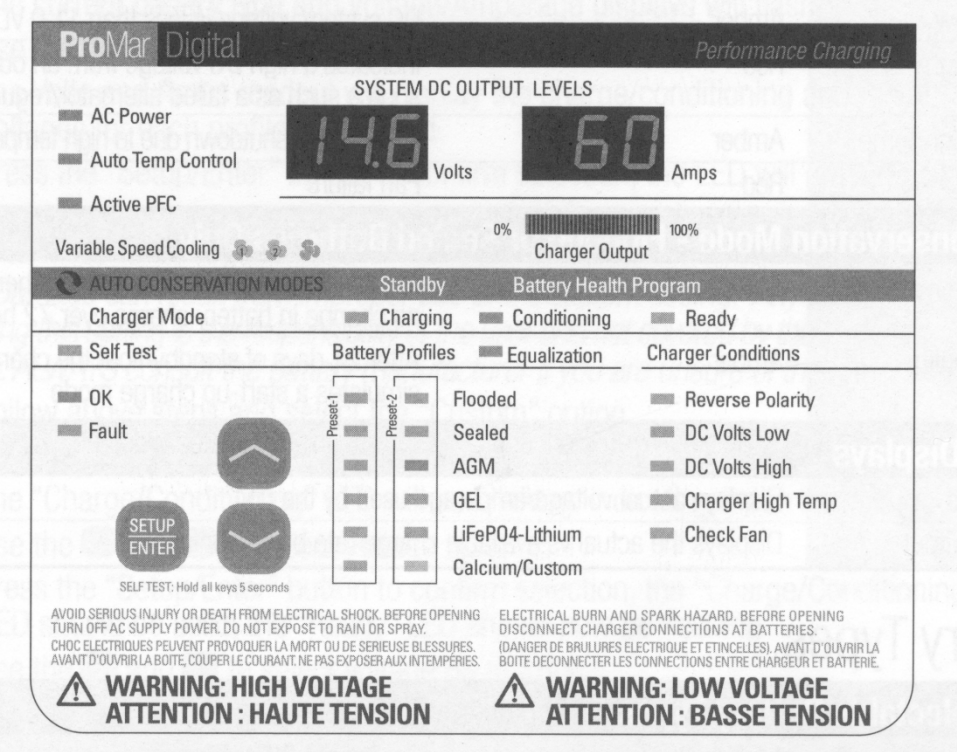


Figure C-0.1: Front panel of the universal battery charger.

LED Indicators and Digital Displays

Feature	Color	Function
AC power	blue	AC power applied
volts		displays charger voltage
amps		displays charger amperage
auto temp control	green	fan active
	red flash	high-temp caused unit shut-down
active PFC	green	indicates that power factor correction is functioning
charger output		displays actual vs available charge rate by percentage
variable speed cooling	amber	indicates speed of fan

Feature	Color	Function
standby	amber	auto conservation mode when no change in charge in 72 hours
battery health program	amber	maintenance after 21 days of standby

Feature	Color	Function
charging	green	actively charging batteries
conditioning	green	in absorption charge mode
ready	green	in float charge mode
self test	blue	performing a system check
equalization	red	equalization charge initiated by user
OK	green	indicates successful self-test
fault	red	indicates fault

Feature	Color	Function
reverse polarity	red	indicates reverse polarity situation
DC volts low	amber	DC system less than 11.0 VDC
DC volts high	red	high DC voltage from outside source
charger high temp	amber	shutdown due to high temperature
check fan	red	fan failure

Selecting Battery Type

To select the battery type/ charging profile, perform the following:
(1) Press and hold "Setup/Enter" button for 5 seconds.
(2) The current battery type and voltage/amperage displays will flash.
(3) Use the up and down buttons to select AGM type.
(4) The Volts/Amps readout will display the charge/conditioning and ready voltages for the profile highlighted.
(5) Press the "Setup/Enter" button to confirm selection; the LED will remain solid.

Self-Test Mode

(1) Press and hold "Setup/Enter" button and the up and down buttons simultaneously for 5 seconds.
(2) Only the "Self Test" LED will flash until the test is complete.
(3) OK or fault LEDs will be displayed.

APPENDIX D: Instructions for the Charge Controller

The Morningstar Corporation Morningstar model TS-MPPT-45 solar battery charger and load controller provides electronically controlled charging, conditioning, and maintenance of the batteries in the PAPI Battery Box Assembly (BBA) . The charge controller is located in the BBA.

Status LED
There are three LEDs that are visible through the front cover of the charge controller with colors green (G), yellow (Y), and red (R). There are three groups of indications: general transitions; battery status; and faults & alarms. The sequencing patterns, which are used for faults, repeat until the fault is cleared.

Pattern examples
- G =green is lit
- Y / R = yellow is lit, then red is lit
- G+Y = green and yellow are both lit at the same time
- G+Y / R = green and yellow are both lit, then red is lit alone

Battery State-of-Charge

80% to 95%	G
60% to 80%	G+Y
35% to 60%	Y
0% to 35%	Y+R
Battery discharging	R

General transitions

controller start-up	G / Y / R (one cycle)
equalize start	G+Y+R / G+Y+R / G / G
equalize cancel	G+Y+R / G+Y+R / R / R

Battery Status

absorption state	G blinking, ½ s on / ½ s off
equalization state	G fast blink, 2 to 3 Hz
float state	G slow blink, 1 s on, 1 s off

Battery Status LED Error Indications:

Over-temperature	Y / R sequencing
High voltage disconnect	G / R sequencing
DIP switch fault	R / Y / G sequencing
Self-test faults	R / Y / G sequencing
Battery voltage sense	G + Y / Y + R

Common Problems

Problem: No LED indications
Solution: With a multi-meter, check the voltage at the battery terminals on the charge controller. Battery voltage must be at least 8VDC.

Problem: The SS-MPPT is not charging the battery.
Solution: Check the 3 LEDs. If they are flashing a sequence, then there is a fault. If the LED indications are normal, check the fuses, breakers, and wiring connections in the solar array wiring. Measure the voltage across the solar input terminals of the charge controller. The input voltage must be greater than battery voltage before charging can begin. Check solar array for shading.

Full testing documentation is available on website:
http://support.morningstarcorp.com/